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THE EDITOR.

PROCEEDINGS

OF THE

PHILOSOPHICAL SOCIETY OF GLASGOW.

NINETY-FOURTH SESSION.

PRESIDENT'S OPENING ADDRESS.

I.—*The Scottish Races: their Ethnology, Growth, and Distribution.* By Dr. Ebrn. Duncan.

[Read before the Society, 4th November, 1896.]

Gentlemen,—Last year you did me the honour of electing me to the office of President, and now, at the beginning of a new session, it is my duty to deliver an address. The subject I have chosen was first suggested to me by a perusal of Dr. Isaac Taylor's book on the origin of the Aryan race, and, secondly, by the circumstance that, while on a visit to Arran, in the month of August last, my attention was directed to a prehistoric tumulus which was constructed of chambered graves. Some of these graves had been opened, and a few of the stones of which they were built were lying exposed at the eastern end of the tumulus. The tumulus itself in its present condition measures about 20 yards in length and 20 yards in breadth; but, as a considerable portion of it at the eastern end has been demolished, and the ground levelled, it is impossible to say what the original length of the tumulus has been. It is quite certain, however, that it was originally much greater in length than in breadth. It is, in fact, the remains of a "long barrow," similar in many respects to those of the neolithic age which have been discovered in many parts of Britain, north and south.

With the assistance of my friend Dr. Parry, I examined one of the chambers of this tumulus. This grave is built of rough blocks

of sandstone, and the stone at the eastern end of it stands about 18 inches higher than the others, and is rounded like the top of an ordinary grave-stone. When emptied of its contents the chamber was found to be about 5 feet square. It had been filled up with earth and large stones, and contained several skeletons, none of which were quite complete. At the south end of the grave we found four skulls, at different levels, in various stages of decomposition. Most of these were so brittle that they went to pieces in the attempt to remove them. The most perfect of them I now show you. In addition to the skulls, we got a considerable number of long bones and vertebræ in very perfect preservation, and also numerous fragments of other human bones of various kinds. We also found the vertebra of ruminant and the skull of a small carnivorous animal. The peculiar construction of the grave, the condition of the bones, and the type of the skeletons, led us to the conclusion that this tumulus was a "*long barrow*" of the stone age.

Archæological investigations have proved that, during the neolithic period, North Britain, like South Britain, was inhabited by a race of people who presented all the ethnological peculiarities which you see in these bones.

They were a pre-Aryan race, Iberian in type, like the Spanish Basques of the present day—short in stature, averaging about 5 feet 4½ inches in height, the tallest being about 5 feet 6 inches. It is believed that, like the Basques, they were dark in complexion, with black hair and eyes; and their skulls were dolichocephalic in type, that is to say, they were long-headed. A similar type of skull was found among the ancient Egyptians, and is still found among the Berbers at the present day. In early neolithic times, the Iberians were cave-dwellers, and lived by hunting.

There is evidence to show that 5,000 years ago they had made considerable advances in civilisation, having domesticated the ox and possibly the horse. The remains of the dog, the goat, the pig, the wild boar, the roe, and the red deer, have also been found in their graves. It is strongly suspected, from the scattered fragments of human skulls and disconnected bones found in some of these "barrows," particularly in Caithness, that these early neolithic cave-dwellers were cannibals, as many of the bones found in the Caithness "barrows" appear to have been broken in order to extract the marrow, and it is therefore supposed that the interment of a chieftain was accompanied by the slaughter of slaves

and captives, and a barbarous feast on human flesh. The neolithic Iberians were not acquainted with the use of metals. A few specimens of rude British pottery, together with stone implements and arrow-heads, represent the only remains of their industrial efforts. Many of these "long barrows" have been found to contain a mixture of calcined bones and non-calcined skeletons, showing that cremation and inhumation were equally common among them. It is possible that in such cases cremation may account for some of the defects in the fragmentary bones which have been referred to. In all these "long barrows" the graves are placed approximately east and west, and, as in the Arran grave to which I have referred, the eastern end is generally broader and higher than the others. Their skeletons show that the ancient British Iberians were a feeble race, and that they frequently suffered from rickets. Many of the jawbones bear evidence that they were afflicted with toothache and alveolar gum abscesses just as much as we who live in modern times. These defects were, no doubt, due to the hardships which they endured, and, as the female skeletons were more frequently affected than the male, it is probable that overcrowding in their damp and unwholesome caves had much to do with these physical defects.

The neolithic period is supposed to have had an antiquity of from 10,000 to 20,000 years.

There is no evidence to show when Iberians first came to Britain, but archæological records prove quite clearly that they were the sole inhabitants of Britain for several thousands of years. The British tribe of Silures, who were found by the Romans in the western parts of England, have been identified with this race. People having similar ethnological characteristics, and therefore their probable descendants, are still to be found in the remoter parts of the Hebrides of Scotland, in South Wales, in Donegal, in Galway, and in Kerry.

About 1500 to 1200 B.C., at the end of the neolithic age or the beginning of the bronze age, a second race appeared in Britain, Turanian or Cymbric, in type, and believed by most authorities to be an off-shoot from the Belgic Gauls. They rapidly spread over the whole island, conquered, and imposed their Celtic language and their higher civilisation on the feebler pre-existing Iberian race. They lived in huts or pit dwellings, and made their weapons of bronze. Like the Iberians, they practised both cremation and inhumation, but they did not build chambered graves. Their remains were

placed in the earth, or in stone cists; and when cremation was practised, in cinerary urns. These remains are found in the "round barrows" of Britain. The skeletons found in these graves show that the Turanian or so-called Celtic race was tall and muscular. They had broad foreheads, high cheek bones, and short square chins. They averaged 5 feet 8½ inches in height, some of them being 6 feet and upwards. In all these respects they resembled the Belgic Gauls, and were supposed to have a fair complexion, blue eyes, and fair hair. Their heads were brachycephalic in type. In popular language, they were moderately round or broad-headed people. The mean cephalic index of 95 British "round-barrow" skulls was found to be 81, while the index of "long-barrow" skulls varied from 71 to 75—averaging about 72. In the "long barrows" no round-headed people were found except in the case of secondary interments; but in the "round barrows" a certain number of long-headed people were interred from the first. This proves that the Iberian race was not exterminated even in the districts where the Celtic Gauls settled in large numbers. The probability is that the long-headed feebler race became the slaves of the more powerful race in these districts, but still retained their liberty in the more inaccessible parts of the island.

As showing that these races have mixed, there is no modern race in Britain with so low an index as the ancient Iberians, and the modern round-headed people of Britain have a lower index than the ancient Celtic races. On philological grounds, it has been believed that, as these "round-barrow" Britons spoke the Celtic dialects, they were Celts, but this is now doubted by many competent authorities. The true Celts—the historical Celts of Cæsar—inhabited the central districts of France. They were a short, dark race, with black hair. The only respect in which they approximated to the British race was in the shape of the skull, which was brachycephalic. But, whereas the mean cephalic index of "round-barrow" Britons was 81, the cephalic index of the true Celts was 84; and the stature, complexion, and colour of hair and eyes in the two races differed so completely, that Broca, the eminent French anthropologist, has maintained that there never have been any true Celts in Great Britain or Ireland. Yet the Celtic dialects of Cymbric and Gaelic were spoken by the whole inhabitants of Britain and Ireland in the time of Cæsar, and continued to be the language of the country until the Anglo-Saxon conquest. The fact that the Silures, who were Iberian in type, and certainly

were not Celts, or even Aryan in race, spoke a Celtic dialect, shows conclusively of how little value the language of a people is in determining the question of race. The anatomical structure of the skeleton, the complexion, and the hair, are much better guides, and in these respects the Celtic-speaking Britons had no well-established claim of kindredship with the Celtic race. In many respects they were a better type of people than the historical Celts of Cæsar.

The first authentic historical notice we have of the inhabitants of Scotland is given us by Tacitus in his account of the invasion of Caledonia by Agricola. He tells us that the Caledonians, whom Agricola met with when he crossed the border, were tall, strong-limbed barbarians, with golden yellow hair, which, he says, plainly indicates their German origin. This opinion of Tacitus is in conflict with the archæological evidence which I have already adduced, showing that the ancient Caledonians were precisely the same race ethnologically as the round-headed South Britons. As the ancients did not measure skulls, it is plain that Tacitus based his opinion upon the stature and red hair of the Caledonians, characteristics which were common to Gauls and Germans. Perhaps red hair was not so universal as it appeared, as it has been shown that their kinsmen, the Belgic Gauls, were so fond of red hair that they were in the habit of using a red pigment in order to give it the admired colour. As our Pictish forefathers painted and tattooed their bodies, it is quite possible that they painted their hair. It may be that the practice of dyeing dark hair a golden colour, which is not unknown among the ladies of our own age, is an inherited tendency handed down from our barbarian ancestors. Although the Romans held sway in southern parts of Scotland for 340 years, their rule was intermittent—insurrections were frequent,—and they did not succeed in colonising the country. They founded no towns, like York, Lincoln, and London: their occupation was merely military in character, and they added no permanent element to the race. About the year 422 they withdrew entirely from North Britain, leaving the country very much as they found it.

In the beginning of the sixth century the Dalriad Scots crossed from Antrim, in Ireland, and rapidly overran the sparsely populated districts of Kintyre and Argyle. The people of Ireland at that time were made up of the same mixed races of long-headed Iberian and round-headed Gaels as the people of Scotland, and

populated, and inhabited by the same barbarian tribes described by Tacitus, whose chief occupation was hunting and warfare, and who had very little knowledge of agriculture, the greater part of the country being still covered with marsh and forest, and unappropriated. This explains the welcome given by the Scoto-Saxon kings to the successive swarms of Angles, Saxons, Normans, and Flemings, and the ease with which land was allotted to each successive crowd of Teutonic adventurers. These men, with their followers, reclaimed the uncultivated wastes of marsh, moor, and forest. By their energy, industry, and familiarity with agricultural pursuits, they transformed the scattered barbarian tribes into a comparatively rich and civilised community. When Sir Walter Scott, in the "Lady of the Lake," drawing on his poetic imagination, describes the Lowlands of Scotland as a country where—

> "Far to the south and east there lay,
> Extended in succession gay,
> Deep waving fields and pastures green,
> With gentle slopes and groves between;"

and when he goes on to say—

> "These fertile plains, that softened vale,
> Were once the birthright of the Gael,"

he ignores the fact that the deep waving fields had no existence until the Saxon came and created them.

During the reign of David I. the mainland of Scotland first became consolidated as a united kingdom, and in the reign of Alexander III. its geographical area was completed by the addition of the Western Hebrides, ceded by Norway. Since his time, for 800 years Scotland has continued a stable geographical area, and a nation, united by common social, political, and religious institutions.

It is a noteworthy fact that the names England and Scotland were derived from the names of tribes which were numerically small minorities of the people of these countries. These names were coined and came into common use about the same time, in the tenth century. They are of no value ethnologically. A man of either country may be a descendant of the Iberian, Celtic, or Teutonic race, or the result of a mixture of two or more of them. As the dialect of Northumbria was Anglian in type, it is almost certain that the greater number of Angles settled there. Their

native habitat in Sleswick was very limited, and their numbers could at no time have been so great as to cover, to any large extent, the other parts of England. Those who did settle south of the Humber were more mixed with the native races, and with the conquering Danes of a later time. Now, as the greater part of Northumbria, which remained unaffected by the Danish invasion, was in Scotland, and the dialect of the Lowland Scots is still an Anglian dialect, as exemplified in the poems of Robert Burns, it may sound paradoxical, but I believe it is true that, ethnologically, if a pure English race is to be found anywhere in Britain, which I doubt, the purest English are the Scotsmen of the south-eastern counties of Scotland, and next to them come the people of Northumberland and Durham. Modern English is a mixture like the people, culled from various sources, chiefly from the Latin, and grafted on a Wessex dialect. In the racial sense, it is equally absurd to call a descendant of the Danes of the south-east of England, or of the Iberian and Celtic people of the south-west, an Englishman, as to call a man a Scot who lives in the south-east or in the north-east of Scotland. There is no doubt, however, that the mixture of these races in different proportions in England and Scotland, and the differing character of the climate and soil, and of the social and national life of these countries, have produced certain differences, physical and mental, and a certain average national type. What, then, are the racial differences between the North and South Britons?

It is commonly believed that one of the great differences between the two countries is that the inhabitants of Scotland are more Celtic in their racial characters. Referring to the mixing of the races in Scotland, one of our most recent historians says—"The result of this union was a mingled race—half Celtic, half Teutonic—in which they differed from the English, who were almost wholly Teuton. And to this large proportion of Celtic blood and character, which was retained unsubdued, and which blended with the Gothic current, may be traced many of those peculiarities of national character by which the Lowland Scots were distinguished from their Saxon kinsmen of England."

In my opinion, the opposite view is the true one, viz., the Scotch are more Teutonic than the English, and the differences which characterise a typical Scotsman, and distinguish him from a typical Englishman, are due to the fact that, by blood he

inherits more fully the racial peculiarities of the Teuton. The following table illustrates this point:—

Scots.		English.	
1. Iberian, long-headed.		1. Iberian, long-headed.	
2. Celtic tribes, broad-headed.		2. Celtic tribes, broad-headed.	
3. Angle and Saxon,	Teutons, long-headed.	3. Danes, broad-headed.	
4. Norwegian,		4. Angle and Saxon,	Teutons, long-headed.
5. Norman,		5. Norman,	
6. Fleming,			

I have already pointed out that in pre-Saxon times there was very little attempt at agriculture, and Scotland was largely covered by forests and marshes. The successive hordes of Angles, Saxons, Normans, and Flemings, therefore, very speedily became a preponderating element. On the other hand, England, even in Roman times, was well populated, and by a people largely occupied in agriculture and commerce; a population so large in proportion to the number of Saxons who could, by any stretch of imagination, be supposed to come from the limited area in Germany where they originated, that it was quite impossible that the Saxon could have exterminated the Britons so completely as early Saxon historians have alleged. The Anglo-Saxons, therefore, must have ultimately absorbed a large element of the native British population, which was round-headed. In this connection, Huxley, in his article on "British Ethnology," writes, "In Britain, the people are vastly less 'Teutonic' than their languages. Whatever may have been the extent to which the Celtic-speaking population of the eastern half of Britain was trodden out and supplanted by the Teutonic-speaking Saxons and Danes, it is quite certain that no considerable displacement of the Celtic-speaking people occurred in Cornwall and Wales, and that nothing approaching to extinction of that people took place in Devonshire, Somerset, or the western moiety of Britain generally." Again, the greater part of the eastern side of England was overrun by the Danes, who, although Teutonic in speech, differed from the Anglo-Saxons in the shape of their skulls, which were brachycephalic. As shown by skeletons of that period found in Denmark and England, they seem to have been like the Belgic Gauls. The Danes, therefore, although not Celtic in speech, were Celtic in their physical characters, and added a large Celtic element to the Saxon population there. Many of the eastern counties of England, from the East Riding of Yorkshire southwards, still

remain Danish in some of their ethnological peculiarities. In Scotland, on the other hand, the Danes never gained a footing. They repeatedly attempted to colonise, but were invariably defeated and driven out.

One of the most conclusive proofs of the larger Teutonic element in the Scottish race, is the fact that the average Scotch head is longer, and consequently has a lower cephalic index than the average English head. English hat manufacturers find that they require to make different shapes of hats for their customers in England and Scotland.

In a reply to an inquiry kindly made for me by Mr. Kirsop, of Glasgow, one of the largest London firms of hat makers, doing an extensive trade both in England and Scotland, give the following as the general run of sizes and shapes supplied respectively to the trade in London and Glasgow :—

London, - -	sizes,	$6\frac{3}{4}$, $6\frac{7}{8}$, 7, -	- $1\frac{1}{2}$ oval.
Glasgow, - -	,,	$6\frac{7}{8}$, 7, $7\frac{1}{8}$, $7\frac{1}{4}$,	- $1\frac{3}{4}$,,

—that is to say, the London heads are $1\frac{1}{2}$ inches greater in length than in breadth; the Glasgow heads $1\frac{3}{4}$ inches greater in length than in breadth. Take the case of a No. 7 hat, with $1\frac{1}{2}$ inch oval, the index would measure an orthocephalic index of 79; with $1\frac{3}{4}$ inch oval it would measure 77, a sub-dolichocephalic index. The heads of the people of the Scottish city are, therefore, on the average, larger and longer than the heads of the English city, and approach more nearly to the dolichocephalic type of the Scandinavian and Anglo-Saxon. Now Glasgow contains a very large proportion of the Gaelic-speaking people from the Western Highlands, where, if anywhere in Scotland, the descendants of the so-called Celts of ancient Britain are to be found in their greatest purity, *a fortiori*, the people of Edinburgh, and of the eastern towns of Scotland generally, must be still more Teutonic in type. This opinion receives considerable support from the interesting, though somewhat fanciful hypothesis of Pösche and Penka, summarised by Dr. Isaac Taylor in his book on the origin of the Aryan race. They allege that the religious divisions of Europe adhere very closely to the racial frontiers; and that the dolichocephalic Teutonic race is Protestant because that type of head denotes independence of character, self-will, and contentiousness; whereas the brachycephalic Celto-Slavic race is either Roman Catholic or Greek orthodox because that type of head denotes submissiveness to

authority, and such people are conservative in their instincts. He also writes, "the Lowland Scots, who are more purely Teutonic than the English, have given the freest development to the genius of Protestantism." A man's attitude towards religious questions may therefore, in this view, be predicted from the shape of his head. England, he writes, "which is orthocephalic, is neither Catholic nor Protestant, but Anglican." This characteristic difference in the attitude of mind in religious questions was met with among these races even before the days of Christianity. The ancient brachycephalic Gauls had a Pope, and their priests held rule with threats of excommunication against those who either publicly or privately opposed them. Men interdicted by the priests were considered impious and criminal, and everyone shunned them. They were outside the pale of justice or honour. The modern Gaels, whether in the Western Highlands of Scotland, or in the Gaelic-speaking districts of Ireland, have the same characters at the present day. On the other hand, the ancient dolichocephalic Teutons had no Pope, and, although they had a priestly class, the priests were of comparatively small importance in the social economy—every freeman was his own judge and his own house priest. So the modern Scottish Lowlanders, who are descended from these dolichocephalic ancestors, are split up into numerous and contentious sections of a Presbyterian Church, in which no priest or bishop is recognised, and in the management of which the laymen have a preponderating voice. It may be some consolation to their countrymen to know that they cannot help it. The shape of their heads, which they inherit with their Teutonic blood, must in future bear the blame of, or obtain the credit for, this national characteristic, according to the point of view of the observer.

Which is the higher form of skull, the brachycephalic or the dolichocephalic, and from which did the primitive Aryan race originate, are questions hotly discussed, and are usually decided, as might be expected in such a case, in favour of the particular shape of head which the writer himself happens to possess.

Large brains and small brains are found in both cases, and men of great mental attainments, are common to both. The cephalic index is of no value in deciding the extent of a man's intellectual faculty, although, as we have seen, it may influence his character. Most of our fellow-countrymen, whether North Britons or South Britons, can calmly take up the attitude of the late Professor Huxley, who writes, in an article on the Aryan question, "The

combination of swarthiness with stature above the average, and a long skull, confer upon one the serene impartiality of a mongrel." We, and our kinsmen, are all mongrels in the racial sense, but mongrels who have, in many respects, proven themselves superior to any one of the breeds of men from whom they sprang. Another point bearing on the racial characters of the Scotch is the stature and physical development of the people. In Scotland, as the average heads are longer and larger than in England, so the people, on an average, are found to be taller. The well-known volume of statistics gathered by Dr. Beddoe, of Bristol, from all parts of the British Isles, shows that, roughly speaking, the natives of Scotland, and of the north and north-east of England (that is to say, of the most Teutonic parts of the island) exceed in stature those of Wales and of the south and west of England. Taking all his facts and figures into account, Dr. Beddoe estimates the average stature of adult Englishmen at 5 feet 6·6 inches, and the average stature of Scotchmen at 5 feet 7½ inches, giving Scotchmen the same average stature as the modern Swedes, who are not only the most dolichocephalic Teutonic race of modern men, but who are, according to Dr. Isaac Taylor, the tallest European race at the present day. In this, again, we have a further evidence of a larger Teutonic element in North Britain as compared with South Britain. The last evidence which I shall refer to at present is the fertility of the women. In vigorous nations, like the Teutonic, this factor in their growth is always high. The comparative fecundity of Scottish married women is greater than that of English women in the proportion, taken over a series of years of 24·7 to 22·1. In 1894, the proportion in Scotland was 456 children to every hundred marriages, whereas, in England, the proportion was 418. Nevertheless, in ratio, the population of England increases more rapidly than that of Scotland. There are fewer unmarried persons of marriageable age in proportion to population in England :—

PROPORTION PER 1,000.

	Scotland.		England.	
	Males.	Females.	Males.	Females.
Single,	663	631	620	596
Married,	304	290	345	329
Widowed,	33	79	35	75
	1,000	1,000	1,000	1,000

The prudential check is greater in Scotland. Whether this is

from greater poverty, or from greater caution, I do not feel myself called upon to determine.

GROWTH OF THE POPULATION.

When the successive waves of Teutonic invasion, which converted Scotland from a Celtic-speaking into an English-speaking country, ceased in the middle of the twelfth century, the mixed races settled down amicably, intermarried, and turned their attention to agricultural and commercial pursuits. A century of peace and prosperity followed.

The ruins of the magnificent cathedrals and abbeys which were built in that age are still with us to testify to the wealth, enterprise and advanced civilisation which Scotland then enjoyed. An approximate estimate by Sir John Sinclair gives the population of Scotland in the year 1250 as 600,000. A century later (in the year 1377) the population of England was estimated at a little over 2,000,000. Scotland was, therefore, in proportion to England, much more populous at that time than it is to-day. At the date of the Battle of Bannockburn, after a 30 years' war with England, in which it is stated that 200,000 men perished in battle, the population of Scotland had diminished to 500,000. From that date, owing to internecine struggles and recurring famines and pestilences, the growth of the population was very slow. At the time of the Union, in 1707, the people of Scotland were estimated in Parliamentary reports at 1,048,000. The population continued to increase slowly until the middle of the eighteenth century, when a great advance in agriculture, manufacturing industry, and commercial enterprise began. With the increase in the means of subsistence which has gone on rapidly ever since, the population of Scotland increased so quickly that, in 1821, it had again doubled The census of that year showed that the population was 2,095,456. From 1821 to 1891, the doubling of the population was again repeated. In the census of that year it was 4,025,647. It is now, in 1896, about 4½ millions. The ratio of the population of Scotland, to that of England, which, in the fourteenth century, was as 1 to 3·5, is now reduced in the end of the nineteenth century to 1 to 7. One of the probable reasons for this reduced ratio may be that, in England, the people marry earlier and in greater ratio to population than in Scotland.

Another reason is to be found in the larger proportional drain of emigration from Scotland.

It is difficult to give an accurate estimate of the number of Scottish people living furth of Scotland. Since the union of the countries Scotsmen have been migrating into England in considerable numbers, and it is a common remark that, of those who migrate there, very few return.

At the census of 1891 it was found that 282,271 people of Scottish birth were resident in England, of whom 144,886 are males, and 137,385 females. At the same date there were also of Scottish birth 27,303 in Ireland.

As most of these people, and their predecessors for several generations, left Scotland as young men and women at the reproductive age, we may safely estimate the people of Scottish birth and descent now living in England and Ireland at 1,000,000.

Taking the emigration returns of persons leaving this country for places outside Europe, I find that since 1821, in round numbers, 1,100,000 have left Scotland under this heading.

I will not trouble you with the figures on which I found my estimate, as it would occupy too much space. I calculate from all the statistics I have been able to gather, and allowing for the return flow of emigrants who have gone forth on temporary business and pleasure, that, at the present time, 650,000 persons of Scottish birth or descent reside permanently in the United States; 525,000 in Canada; 570,000 in Australia and New Zealand; and 250,000 in other parts of the world—in all about 2 millions. I estimate the Scottish population of the world at 7¼ millions at the present time. The thrift, honesty, and self-reliance of the Scottish emigrant, and of the average Scotsman everywhere, are due to the mixture of the racial elements to which I have alluded, and to the centuries of struggle which his ancestors endured. The warfare, the barren soil, the marsh, the forest, the rigorous climate, have all contributed to weed out the weaklings. In the long run, in such conditions, the strong and the fit alone survive.

DISTRIBUTION OF THE POPULATION IN SCOTLAND.

According to the last detailed report of the Registrar-General for Scotland the distribution of the population in 1894 was as follows:—

Urban population, - - - - -	3,061,011
Rural „ - - - - -	1,063,680

These figures prove—First, that the rural population of Scotland is as large as it ever was; and, in the second place, that now, in round numbers, 3 persons live in town for every 1 who lives in the country.

In England, according to the census returns of 1891, 20,895,604 persons were found in the urban sanitary districts, and 8,107,021 in the rural.

The proportion, therefore, of town dwellers was as 258 to 100; now, an urban sanitary district comprises not only the towns, but also the districts around, which are, more or less, closely populated. Presuming, therefore, that these two statements with regard to town dwellers are calculated approximately on the same basis, Scotland has a greater ratio of urban population than England, and is, therefore, in proportion to its numbers the greatest urban community in the world. In the end of last century Malthus published his interesting and learned essay on the "Principle of Population," in which he stated as axioms—1st, that, when unchecked by misery, warfare, or pestilence, population goes on increasing in geometrical ratio, as 1, 2, 4, 8, 16 (doubling in number every 25 years); 2nd, that the means of subsistence cannot possibly be made to increase faster than in arithmetical ratio, as 1, 2, 3, 4, 5. A century has now elapsed since he stated that, in his opinion, Scotland was over-populated. If his theories had been correct, we should long ago have suffered from famine and pestilence, but the logic of facts has shown that his second axiom is fallacious, for, with modern appliances, food and wealth have increased even more rapidly than population, and the people of Scotland are now richer, better fed, better clothed, and better housed than they were in Malthus' time. Every civilised and educated man added to the population is a source of wealth and power to his country.

I have endeavoured in this address to sketch in rough outline the gradual growth of the people of Scotland, from the feeble barbarous tribe of Iberians into a numerous civilised and progressive nation of city dwellers. In recent times the rapid growth of the towns, and the unfavourable health conditions of the masses of the workers, which this rapid growth of urban communities involved, threatened to diminish the physique of the people, and led to a great amount of preventible disease, suffering, and death. If time permitted, I could show, by facts and figures, that by the efforts of sanitarians and philanthropists, and our greatly increased

knowledge of the laws of health, we have been able in some measure to arrest the downward progress, and that during the last thirty years there has been a very marked diminution in pauperism, insanity, drunkenness, and disease. I hope on some future occasion to place these facts before you. Meantime, from the history of our successes in the past, I have confidence that the sanitary and social problems, still to be faced, will be successfully grappled with. In favourable conditions, even the children of the deteriorated workers in our city slums may recover the vigour which their fathers have lost. If our towns are made what they ought to be, and can be made, the physical characteristics of the Scottish race will reassert themselves, and the classes which have become dwarfed and deteriorated will regain their strength and their stature. We and our rulers must see to it that these favourable conditions are achieved, and that no private interest is permitted to prevent the healthy development of the people. For now, on the workers in our cities, the whole social fabric rests, and if the foundation decays the edifice must fall. In the words of Lord Bacon—"The true greatness of a State consisteth essentially in the population and breed of men."

PRESIDENTIAL ADDRESS.

II.—*Art in our City.* By P. Macgregor Chalmers, I.A., F.S.A.Scot.

[Read before the Architectural Section, 16th November, 1896.]

It is with no very certain hope that words of mine can exert any influence that I venture to address you to-night on "Art in our City," directing your thoughts, for a brief period, to what has been done, and to what might be done, endeavouring also to trace something of the thought which has inspired, and which ought to inspire, our efforts in this direction. The attainment of the beautiful in every object that surrounds us is admitted by all to be of the highest moment. An artistic environment improves the manners of the people. It civilises and exalts their minds by informing them, on every hand, of the greatness of the past, and of their indebtedness to it; by enlisting their active sympathies in the work of the greatest minds of their own time; and by calling upon them, in the spirit of sacrifice, to consider the highest welfare of their children.

It was stated recently, in a metropolitan journal devoted to municipal affairs, that "Glasgow holds the first place for the extent, if not for the variety, of its municipal institutions. The civic spirit which animates its citizens, and the business capacity brought to bear on its problems by its municipal statesmen, are the envy and admiration of other communities. The science of city government has, perhaps, on the whole, reached a higher state of perfection in the northern metropolis than in any other city we know." This is praise indeed, and, perhaps, not altogether ill deserved. But it is not my province to speak of the energy which has transformed a small rivulet into a great waterway, bearing leviathans on its bosom; which brought the bright waters of the loch, set amidst the green hills far away, into every home; which furnishes us with light and power, and carries us whither we will; which guards our lives and property, and, with the most perfect knowledge of science, works wonders in the preservation of health. All this is done and more besides. I would speak rather of those things which help to raise us above considerations of mere physical gratification.

Sordidness, vulgarity, and irreverence are the fruits of material prosperity and care of the body alone, and it is probably the general experience that these ill qualities are most manifest in those towns or villages of mushroom growth, whether here or in the west, which are the seats of recently-introduced and successful manufacture. Modern Glasgow has grown rapidly, and there has been so constant and so great a stream of strangers into our midst, to whom the past of the city's life is nothing, and so little is done to keep alive the sentiment which is always linked to what is old, that it is small wonder if the good influence which the memorials of the past are capable of exerting is almost wanting in our midst. Whilst abating in no way the efforts to secure general advancement, it would be well also to endeavour to preserve all the old memories, and to make their influence felt more widely and effectively.

Our City Arms speak to us of far-distant days. However they may have originated, they embody part of the life-history of one to whom, in great measure, our country owes the introduction of Christianity, and to whom Glasgow owes her foundation. The memory of Saint Mungo, however, is gratefully revered by a few, from his association with our beautiful cathedral, as it stands on the ground which was consecrated by him, and on which he reared a modest church—revered by a few, in this connection, since it must be confessed that the great majority of the citizens have never seen the building, and nothing is done to foster the spirit which would attract them to it.

There is one story in connection with it—a fable, however—which always finds ready acceptance, and that is the story of the rising of the city tradesmen to preserve it from destruction by religious fanatics. And there is generally indicated, even by the least interested, a readiness to follow their example should danger again threaten. Fanatics might be useful now.

But there have been vandals in every age, even in the golden age, and we may have them again. The most ancient statue in Glasgow, the effigy of Bishop Robert Wiseheart—the patriot and the friend of Bruce—was still vibrating from the touch of the great Scots sculptor, the echo of his last stroke had scarcely died away, when the Philistine lifted his hand and hewed away the feet. It is only some fifty years since the cathedral was robbed of its western towers, destroying for ever the picturesque grouping of the building. And only a few years ago it was proposed to destroy

the interesting monuments which enclose the cathedral churchyard, and which form so necessary and so appropriate a feature in the foreground. It was evident that the authors of this proposal had little reverence, and no artistic perception. It is our good fortune, however, that in this case remonstrances were not wanting, and the monuments remain.

I never visit the cathedral but I feel how profoundly it loses in effect because of the bareness of the nave from the absence of any furniture. This great structure, erected by the labours of many centuries, and devoted to the service of God, we leave in desolation, with this exception, however, that in one corner we tolerate a shop, with not a little scandal to ourselves. A better appreciation of our greatest art treasure would be shown by our using it again for service, and at what little cost? An expenditure of about £400 or £500—the price of a picture or a drawing-room carpet—would provide a sufficient number of chairs, benches for the choir, and a pulpit. If this is done a reproach will have been removed, and the beauty of our cathedral will have become more than ever apparent. Only then may we compare it with such structures as Notre Dame in Paris or of Chartres Cathedral. With the nave thus used and adorned, the choir would be set apart, one would hope, for other services and for communion. The present contracted solid benches ought all to be removed. There is nothing so inartistic or so destructive of architectural effect as the apparent resting of walls and pillars on the top of timber pews, a defect which is most marked in our cathedral. The bases of walls and piers should never be obscured, but should be visible down to the level of the floor from which they spring. This is most effectively secured when the aisles are kept free from every encumbrance. For the services of the choir, benches on each side of the mid aisle might very properly be provided. There is no detail of the old structure of which we have more interesting record than the choir stalls. The contract is still preserved, between "the dene and cheptour of Glasgw on the tapairt, and Mychell Waghorn, wrycht, on the toder pairt," and the date is 8th January, 1506. In this document Mychell was taken bound to adorn the stalls "on the best fassone," and, so far as can be estimated, these extended forty feet on each side, with a cross piece on the west, behind the rood screen. It is interesting to observe that, in a matter of this kind, individual interest was aroused, and individual taste consulted, for it was arranged that whatsoever canon should erect his stall more

expensively than the common stalls should pay the extra expense out of his own funds. All this fine carving has now disappeared. We know nothing of its design, beyond the statement recorded that it was to be after the pattern of the stalls in Stirling Church, and that, for the principal fronts, these were to be "specialy efter the forme of the frontell of the silouris of the hie altare in Glasgu." Had the present screen behind the communion table been made in timber of the best and richest workmanship available, it would have been more fitting than as made in white stone, since it would not only have been on the old lines, but it would have harmonised more perfectly with the tone of the ancient masonry.

The feature in our cathedral which renders it unique as a work of art is the lower church, and many a visitor has come from far to see it and to study its beautiful plan, and the wonders of its interesting vaulting. But no one can see it. It is to be feared that art is too little appreciated amongst us, or we would not be content to leave one of the most wonderful art productions we possess to almost perpetual darkness. But this lower church was designed for light. The most elaborate carvings in the whole structure are to be found in the chapter-house door, and these were meant to tell their story to the eye. The stained-glass windows, obscuring the light, were a fatal mistake, and he who can secure their removal will deserve well at our hands.

I have referred to the cathedral at this time at some length, because it is desirable that it should be appropriately and well adorned, for it is our greatest art treasure, and will always remain such. It is the creation of centuries of thought and labour on the part of priest, and artist, and craftsman, and, offer what sums we may, we shall never be able to purchase or to produce anything to equal it in its power to elevate even the meanest and most sordid, whilst the most cultured in its contemplation may feel that

> "Upper life the slender rill
> Of human sense doth overfill."

Whilst in a manner we hold a proprietary claim over our cathedral, it would be well if the citizens, whose motto is "Let Glasgow flourish by the preaching of the Word," recognised that they have even a larger and more direct interest in other religious structures, and that the holding of property carries with it certain obligations and the necessity for the performance of certain duties. The heart of the city, during the last quarter of a

century, has been greatly changed. The population has in some considerable measure been removed, houses having given place to shops and warehouses. If this is true, then the church accommodation formerly provided must be greatly in excess of what is required. Looked at from a business point of view, this is a defect which ought to be remedied. I believe the time is now, or is nearly, ripe for some of our city churches being dispensed with, and the question may be asked, How best can the citizens discharge their duty in the matter? The sale of the fabrics and sites and the appropriation of the money so acquired to the erection of other churches on the outskirts of the city hardly commends itself. A more perfect solution would be found in the merging of the several churches into one new church, on a site, it may be one of the present sites, or a new one, but still in the heart of the city, on or near some busy thoroughfare. The citizens would, in this way, again have an opportunity, after many years, of erecting a city church, and a great and beautiful church it ought to be, for it is not impossible that a sum of about £40,000 would be available. This is an object every citizen could support. It would be but discharging a duty. And in a city which, perhaps, beyond all others, is forward in the recognition and performance of its duty in relation to the physical welfare of the people, as shown in the provision of healthy recreation, open spaces and galleries, homes and shelters for the poor, and hospitals for the sick, there would be presented an opportunity for the general recognition of the benefits to be derived from religion. Such a church should be expressive of the devotion of a great city; it should be rich with the offerings of the people; "such a church as it should be a joy and a blessing even to pass near in our daily ways and walks, and as it would bring the light into the eyes to see from afar, lifting its fair height above the purple crowd of humble roofs;" and from its ever-open door there should pour a continuous stream of sweetest harmonies.

If there is no finer scale by which to measure the soul of a people than the character of its churches, it will be admitted that one of only a little less perfection is presented by its monuments and memorials. By the one it is possible to estimate the spirit of adoration and the spirit of sacrifice. By the other, shall we not tell to what extent the spirit of its hero animated the people, how great and noble were the thoughts which inspired the memorialists, and in what manner, if at all, inspiration was secured

for future generations. In the truest possible sense, a monument is reared to the memory of its builders.

The greatest monument in Glasgow—the largest in size, at least—is Nelson's Monument in the Green. Seen from a distance, the outline has a certain appropriateness, since it is suggestive of those famous obelisks whose home was on the banks of the Nile, a name ever to be associated with the memory of our greatest admiral. A closer inspection is disenchanting, and one almost instinctively looks around for the ruins of a factory. And this gaunt, chimney-stalk-like structure, of no more value than the unhewn rocks by the sea shore, is guarded, as if it was a great treasure, by a high and ugly cast-iron railing. The thought which inspired the form of the memorial I conceive to have been the essentially vulgar one of getting the biggest, not the best, value for the money expended. There is nothing present to kindle the emotions, or to bring to mind the great deeds wrought for the liberty of nations. There is no sculpture work, and even the words "England expects every man to do his duty" find no place there. The battle of the Nile was fought on the 1st of August, 1798, and not many years passed before the final victory. We are thus on the eve of the centenary. It will be interesting to observe if, in this great maritime centre, these days are allowed to pass without some effort being made to redeem the past, without some addition being made which will show that the spirit which was in Nelson still finds an echo in our hearts.

Not far removed from this monument is a recent memorial to one who lived an honourable, if not greatly distinguished, life amongst us. The memorial to the late Bailie Martin might be called a fountain, but it never murmurs to us of mountain streams, and there is no placid lake on which the sky may be reflected. In truth, it is only a plumber's fixture, a public necessity, for the thirsty must be satisfied. It is evident that more funds were provided than would purchase the well alone, and it was found possible to give that appearance of bulk, so much desired by many, by the erection of a circular dome carried on columns. But the dome gives neither cover nor shade, since it is constructed of open tracery. The structure is made of cast iron, which is the worst possible material for a work of the kind. It is coated with paint now, but when this is neglected, it will linger on as a wreck until it is broken up and removed. The committee entrusted with its erection had no tender thought. The well is to be found in many

streets and many towns, and the dome is chiefly known amongst us from its association with our public conveniences. But there is one feature to which reference has not been made. A tiny eagle surmounts the dome, but for why I cannot tell, unless that the casting was cheap. A public memorial of this kind is an affront and not an honour, and it is far from creditable to those who erected it.

A little further west another well is found, erected to the memory of Sir William Collins. The material here is, wisely, granite and bronze, but there is no broad basin with its gleaming water, and the design is cold and dead. Those who erected it may, in the figure of the little child standing on the top of the column, in perilous case, have endeavoured to convey some tender thought that was appropriate to one who was in his lifetime placed at the head of our municipal government. But I have failed utterly to apprehend their meaning.

Coming to the busier haunts, perhaps the oldest fountain in Glasgow stands in George Square, It also is of granite. It may be called a fountain, for there is a basin, although it is only thirteen inches broad, and there is a jet of water, although it is only twelve inches long. The basin is there, certainly, for one may often see the children climbing up, or helping each other up, to see the bright drops falling back into the tiny lake. But there is no art here, and it is all so terribly small.

Nothing, however, is so small but there may be a smaller; in witness whereof, find the monument erected by the citizens of Glasgow to Bailie Torrens. This is a plumber's fixture, a public necessity in the busy New City Road district. It is of granite, but there is no art, nothing which can speak to us of the man and his life.

Penetrating still further, there is a gleam of hope in the distance, for, in the open space lately acquired at Garscube Road, there is what seems to be an ideal fountain. Closer inspection leads to disillusionment. The design is a monstrosity, the material is cast iron, there is no water, and the whole is fast going to wreck. Instead of playing round the margin, the children of the district desport themselves inside the empty basin. It was recently announced that the Corporation will be pleased, during a few summer months, to supply water on Saturday afternoons. Would the better plan not be to remove the unsightly object altogether.

The fountain in Cathedral Square is unworthy of any higher

commendation. In this case, too, wreck is written largely upon it. The fact that it is now well guarded by a plot of ground and a railing might lead the unwary, however, to imagine that it was worth preserving.

The most recent addition to our city is the Sir Charles Cameron Memorial at Woodside Crescent. It is difficult to know in what terms to describe this structure. It is evident, however, that the wish to serve the physical wants of the people, and not their spiritual wants, has inspired the design, and it is singular to find how unanimous opinion is in declaring that it leaves much to be desired.

Glasgow possesses two memorials, in the form of fountains, of which she may be justly proud. In both the foundation of the design is a broad shimmering pool, into which the jets of water plunge and dance. The fountain in the West-end Park is not alone a monument to Provost Stewart, or of the introduction to Glasgow of Loch Katrine water. It stands as a lasting testimony to the good taste and discernment of the committee who selected the design, and, more than all, it is a memorial of the rare genius of its designer, the late Mr. Sellars. Here the broad basin of water is placed at a level well below the eye, so that no part of its beauty may be lost, and out of this grows a most graceful Gothic structure, in every part betraying the hand of a cultured and loving fancy. No one who visits this fountain on a Saturday or a Sunday can doubt that it exercises a widespread influence for good. It is possible that the impression might be conveyed to the mind of a stranger that there are so many beautiful fountains in Glasgow that we can be reckless with them to extravagance, for this fountain stands but a few yards from a most delightful artificial pond, and, not many yards further, there flows the River Kelvin. Our pleasant spots are closely centred.

A somewhat similar thought arises in connection with the Jubilee Fountain in the Green, as it stands but a few yards distant from the River Clyde. This Jubilee Fountain is constructed of terra-cotta, and is well designed, the groundwork of the whole being a broad rim encircling a sheet of water. There is much that repays the closest study, and one feels it is not unworthy of the donor or of the city. It may be doubted, however, whether the citizens are worthy of so great a gift. They evidently despise it so much that a broad stretch of earth and an iron fence have been placed round it, so that by no chance may

they find the greatest meed of pleasure in it. And what of the children? Deprived of their happiest playing ground, they have taken to throwing stones at it. If, as some will have it, the breaking of the railings at Hyde Park led to the passing of the great Reform Bill, then we may pray that some serious destruction may be wrought on this fountain, if, by that means alone, it is possible to have it restored to the use and pleasure of our people and their children. Education comes, not by deprivation, but by use. It is true, doubtless, that the margin, being made of terra-cotta, is too fragile. Why not remove it then, and substitute granite, or, better still, extend the fountain by adding yet another basin, placing a granite kerb at the line of the present obstructive railing?

There are few places in a city more fitted for decoration than the narrow fronts formed by the junction of two converging streets. These could be adorned with sculpture, or a beautiful fountain could be made which need in no way interfere with the thoroughfare. There are no examples of such treatment in Glasgow; but to show how delightful gussets may be made, it is only necessary to refer to the beautiful Molière Memorial in Paris, or to the still more beautiful fountain of Saint Michael.

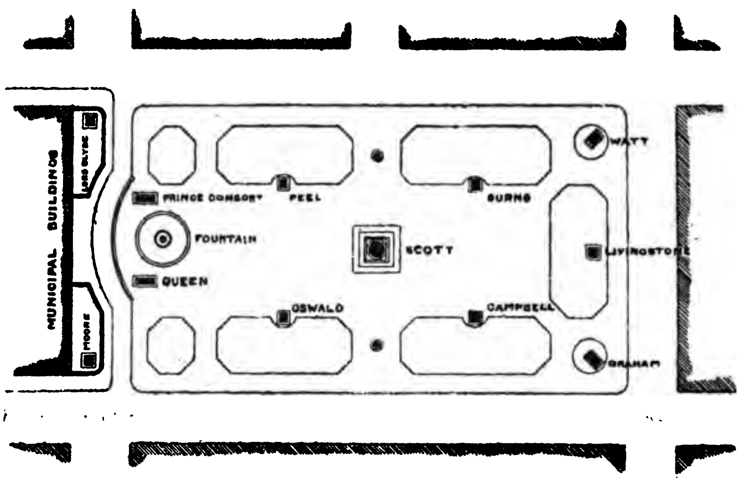
I have dwelt long on the subject of fountains, as these may be the source of more true pleasure to the community than any other objects of art, and on them we should be pleased to lavish the best that the greatest artist can produce. It is no pleasant discovery to find that in the city, where we require them most, we do not possess a single fountain. We have the finest water supply of any city in the world. But what have we to compare with the fountains of Paris, or what with the fountains of Rome? "In every one of the fountains of my Rome a naiad, or a satyr, a god, or a genius has taken refuge, and in its depths dreams of the ruined temples and the levelled woods, and hides in its cool, green, moss-grown nest all day long, and, when the night falls, wakes and calls aloud. Water is the living joy of Rome. When the sky is yellow as brass, and the air sickly with the fever mists, and the faces of men are livid and seared, and all the beasts lie faint with the drought, it is the song of the water that keeps our life in us, sounding all through the daylight and the darkness across the desert of brick and stone. Men here in Rome have 'written their names in water,' and it has kept them longer than bronze or marble. When one is far away across the mountains, and can no

more see the golden wings of the archangel against the setting sun, it is not of the pictures, not of Cæsars or senators, or palaces, not even of the statues, that you think with wistful longing remembrance and desire, it is of the water that is everywhere in Rome, floating, falling, shining, splashing, with the clouds mirrored on its surface, and the swallows skimming its foam. I wonder to hear them say that Rome is sad, with all that mirth and music of its water laughing through all its streets, till the sleepiest and stoniest ways are murmurous with it as any brook-fed forest depths."

To the absence of any fountains in our city we have to add the absence of any imaginative piece of sculpture. But we are not poor, as cities go, in memorial statuary, although the art is not always of the highest excellence. The placing of statues requires the exercise of the finest judgment and taste. The custom of erecting them in open squares, with no environment, is indefensible. The feeling of isolation is fatal to the fullest appreciation, and the work, from many points of view, lacks force and direction. Statues are never so successful as when they are associated, either closely or distantly, with an architectural work; and they are mutually helpful, for not only will the proximity of a beautiful piece of sculpture add to the expression of a building, but it will, by introducing an object of smaller scale, increase its apparent dignity. The equestrian statue of King William, to whom the citizens owe their freedom, and the proud privilege which they exercised only a few days ago, is beautiful in itself, and it owes much of its effect to its long and close association with the picturesque front of the old Tolbooth. There is every reason to be proud of the equestrian statue of the great Duke of Wellington, nor is there less reason for pride in the front of the Royal Exchange. There are few, however, who will not admit that the beautiful background of the building adds immensely to the artistic effect of the statue, and that, were the statue wanting, the façade of the Exchange would be dull and expressionless.

In George Square the ill effect of want of background and of isolation is most apparent. And yet few finer opportunities were ever offered. It is somewhat singular that when our great Municipal Buildings were erected, on the east side of the square, with the principal façade turned westward, nothing was done to remedy the defect caused by the statues standing at right angles to it, with all the faces turned to the south. The present arrangement

was, doubtless, appropriate enough when the two great hotels on the north side were the most important structures in the square. That place has now been taken permanently by the city buildings, and the statues ought to be turned facing the west. But the square would be greatly improved by other alterations, chief amongst which I place the removal of the unnecessary street in front of the Municipal Buildings, and the substitution of a narrower private carriage-way. At the north and south corners of the Municipal



Buildings the exquisite statues of Moore and Clyde might find a place. Forward, on the west side of the carriage-way, and in line with the turrets flanking the principal entrance, might stand the equestrian statues of the Queen and the Prince Consort, and between them could be placed a beautiful fountain. The statue of Scott would be turned facing to the west, and, forming a square with it, there would be, on the east, Peel and Oswald, and on the west, Burns and Campbell, all facing to the west. In the spaces north and south from Scott, there could be small drinking fountains. Livingstone and Watt would remain as they are, and Graham would be brought to the north-west corner. The square would, in this way, be designed in relation to the Municipal Buildings; it would be increased in apparent size; and the effect of the buildings would be greatly enhanced, not only from the general arrangement, but also from the close association of the beautiful statues of Moore and Clyde, the Queen and Prince Consort, and a fair, round fountain. This fountain might be a

memorial of the new water supply, soon to be completed. It should have a broad, low basin as a first necessity. Then, if we will not employ a great artist to design it, let us be content with the basin, and employ a plumber to fit one or two nozzles to throw the bright water high in the air. But why should Glasgow lag behind Perugia of old? "And the Perugians having, at the same time, brought from the mountain of Pacciano, two miles distant from the city, through canals of lead, a most abundant water, by the invention and industry of a friar of the order of St. Silvester, it was given to John the Pisan to make all the ornaments of this fountain, as well of bronze as of marble; on which he set hand to it, and made there three orders of vases, two of marble and one of bronze." The suggestion has been offered that the two statues, Foley's Lord Clyde and Flaxman's Sir John Moore, might have a place of honour in front of the Municipal Buildings. But would it be possible to find any more beautiful or fitting adornment for the interior of the building than Flaxman's exquisitely eloquent marble statue of Pitt, the great Prime Minister, at present buried in the Corporation Galleries? It is true that the sculptor's art has not been neglected in the Municipal Buildings. Much of it, however, is wanting in expression, and is devoid of purpose. But this is referred to now with the hope of directing attention to the work of the future, and especially to the new Fine Art Galleries, for the decoration of which a considerable sum has been set apart. It would be well if, from unnecessary and meaningless scrolls and pinnacles, some little could be saved, and devoted to the production, by a Gilbert or a Thornycroft, or other eminent sculptor, of a group which would be as a jewel set in the midst, and an honour to our city.

Glasgow has many bridges, and not many objects present better opportunities for adornment. Yet how little has been done amongst us. There is a sort of unwritten law that a bridge pier must of necessity carry a lamp-post. And so unbending is this law, that lamps deface the piers of the not-too-attractive railway bridge across the Clyde at the Broomielaw. But piers and lamps are separable. If lamps serve their purpose most effectively in our streets when they are placed on the edge of the pavement, they will be as effective there when lighting a bridge. There they ought to stand. With the lamps removed, the piers could be treated architecturally, or they could support groups of sculpture, or, perhaps more pleasing still, the cornices and parapets could be

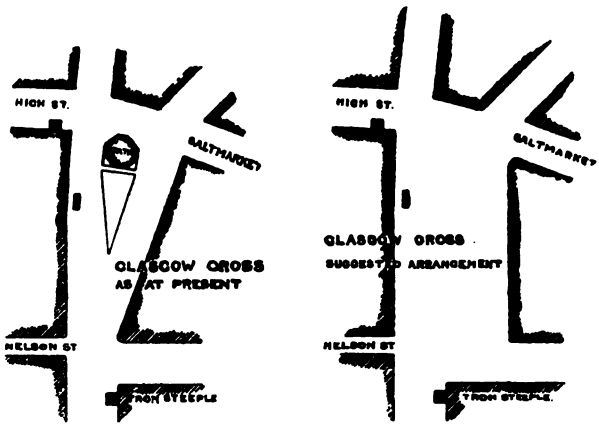
carried round in order to provide convenient recesses into which, on chance meeting, friends might retire to escape the jostling of the crowd. But the four piers which terminate the wing-walls of a bridge offer an opportunity for the display of sculpture which has never yet been appreciated here, but is utilised with immense advantage elsewhere. Subjects there are in plenty, and, perhaps, for a first piece, no better subject could be suggested than the model of one of the beautiful horses, of which so many are to be found in our streets. The perfect form and high mettle of our famous Clydesdale breed are inspiring sights; and we know how beautiful the statues of such creatures are when wrought by the hand of a skilful artist, as in the horse at Eaton Hall, by Boehm, of which we in Glasgow possess the original plaster model, or in the spirited "Chevaux de Marly" in Paris. Used in a legitimate manner, with proper regard to the character of the material, there is no reason why both cast iron and wrought iron should not enter into the construction of the arches of our bridges. It is not easy, however, to justify the present use of cast iron in the parapets. It might be possible to design cast-iron parapets of great beauty in design and workmanship, but the attempt has never been made, and the necessity for constant painting is an almost unsurmountable obstacle. If the parapets of the Great Western Road Bridge are compared with those on the beautiful bridge recently erected in the West-end Park, one would fain hope that the day of such parapets is ended. Before leaving the subject of bridges, it may serve a good purpose to refer to one other, a small affair, entirely of iron, with huge girders standing above the pavement level, and as ugly as can be. It is one of the bridges spanning the Kelvin, in our most classic spot, the West-end Park, close under the University, and within a stone's-throw of our new Fine Art Galleries. The designer provided a pavement only four feet wide on each side; then he placed the cast-iron cornice sufficiently high that it might strike the eye, or the mouth, of the unwary passenger, and he projected it on the piers to the astounding extent of 1 foot 10½ inches. This bridge has now stood for eight or nine years, a monument of the designer's incapacity, and a positive danger to the citizens.

So long as it is decreed that the sweet influence of the soft, green hand of Nature shall not be felt in the midst of our city, life in Glasgow is, at least, rendered tolerable by the beauty of its parks. There are many delightful features there, not alone in

flowers and shrubs, but in objects of recent construction, which have brought pleasure to countless numbers. But the entrances to these paths of pleasure have never been becoming or appropriate. It is true that in one case, some little time ago, a great arch was erected at a minor entrance to the Green—the M'Lennan Arch—a structure, in the beauty of its design, not unworthy to be compared with any of the arches of the Continent; yet, by some cruel fate, this was placed at a spot so unsuitable that it can only be viewed from one point, and from London Street it is almost hidden away, whereas it was worthy to form the principal entrance, and to stand in front of the Jail, and in line with the Jubilee Fountain and Nelson's Monument. The entrance gateway recently formed at the north-west corner of the West-end Park is poor and insignificant, and is no improvement on the previously existing cast-iron railing. But we may reasonably hope for better things in the proposed new entrance at Kelvingrove Street, and that gradually, possibly by the introduction of sculpture, the entrances to all our parks will be made more worthy.

The streets of Glasgow are broad and well paved, and, as a rule, are ordered on a rigid rectangular plan, but the buildings which bound them lack in picturesqueness. There is, however, one picturesque view still in Glasgow—in Trongate, looking eastward from about the corner of King Street, and the remarkable beauty of the scene is not dimmed by the consciousness that much of the ancient civic life centred in this spot. Those who aided in the preservation of the old Tron Steeple have earned the gratitude of everyone interested in the beauty of our city. It is with some considerable fear for the result that one learns that it is proposed to widen Nelson Street, for the effect might easily be disastrous. But this may be avoided by the exercise of care and judgment, and extreme care and the rarest judgment will be required. The effect of the City Improvement Trust's work on the south side of Trongate, at the Cross, has been most unfortunate, and there is no part of the city which I visit with more regret for the things of the past. I believe it is beyond the power of man to make a street beautiful when its sides are not parallel to each other. Looked at from either end the perspective is absolutely destroyed, and proper perspective is the first requisite in such circumstances. The city improvement scheme at the Cross offered a magnificent opportunity for beautifying the city. If, instead of gradually widening Trongate until at the east end it was sufficiently broad

to embrace both Gallowgate and London Street, the buildings on the south side had been set back parallel to the north side, a square would have been secured, measuring, it may be, about 150



feet across, a square far excelling George Square in interest and picturesqueness. This opportunity, however, seems lost for ever. There should have been no railway station there. But now that it is there, we may regret the too large scale adopted in the present structure, which tends to dwarf the proportions of everything in the neighbourhood. The design calls to mind some of our ancient market crosses, and it calls to mind that on or near this very site there stood the old market cross of Glasgow. It would have been a pleasant thing if the railway company, which has gained so much from the city, had authorised the covering in of their station with a flat concrete roof, and that from the centre of this there should have been reared a great cross shaft. We would then have had a structure comparable to that which Edinburgh owes to the munificence of Mr. Gladstone—but not to be crowned, it might be hoped, by a meaningless unicorn or griffin, but by a simple cross, so that the hopeless and unfortunate, who still haunt this neighbourhood, should hear some echo of the words of the prophet of old—"Is it nothing to you, all ye that pass by. Behold, and see if there be any sorrow like unto my sorrow."

There are few examples of buildings in Glasgow where, in order to secure a more enhanced effect, ground has been sacrificed, the advantage of which is so well illustrated at the National Bank in Queen Street. It is too often the case that the first and last

object is to utilise every inch of building ground, and to construct at the lowest possible cost. In recent years, however, attempts have been made, and in some cases with great success, to break away from the terrible monotony of our interminable draught-board pattern of unbroken fronts and square-cornered crossings. Already there are several examples of beautifully treated corners, where, without any considerable loss of building ground, great picturesqueness has been secured, with a greatly improved appearance to the building. There might be a still further improvement if, abandoning the square-cornered crossing, the open octagon was occasionally adopted, as at Gorbals Cross, where, however, the buildings are mean, but to be seen with splendid effect in other cities. It would probably be necessary in such cases for the Corporation to acquire the ground unbuilt upon, since the recent action at St. Andrew's Street has doubtless put an end, for some time to come, to disinterested action on the part of the citizens.

It is to be feared that in a great number of the buildings in Glasgow there is too much architect in evidence, and too little art. In many, the proportions of voids to solids, the proportions of openings, the proportions of cornices and shafts, and the proportions of every feature down to the smallest mouldings, are as perfect as an early acquaintance with "Chambers" can render possible, and yet the buildings are deadly dull. Much money has been spent, even in the best examples, in order to secure the essentials of simplicity and good proportion. But expression has too often been ignored.

In the Junior Conservative Club we possess a work of almost perfect proportion. It would hardly be possible to alter a shaft or cornice without injury. The architect has done his utmost. The sculptor, however, instead of being called in to give his aid in securing that expression which is always to be found in perfect art, has been forced to the level of a machine, to turn out a certain number of capitals all exactly alike, so many yards of meaningless scroll, and a number of mask faces, the contemplation of which can bring pleasure to no living soul. Or, take another example, the much-admired Great Western Terrace. Seen from a distance, the effect is very good, as it is simple in outline and well proportioned; but simplicity and good proportion may be found in many of the cliffs around our shores, or in the walls of many of our ancient castles. Viewed closely, however, Great Western Terrace is found to be a number of separate homes, where dwell

as many families, each having its own individuality. Yet all the houses are alike, and there is not a stone which has been devoted to the expression of a single thought. Simplicity and good proportion are admirable, even essential qualities, but they are not the end for which we ought to strive. Happily, of late, evidence is not wanting that our architects are recognising the poverty of past efforts, and there is growing amongst them a strong desire to enlist again the sympathetic labours of sculptors and painters, not binding them, as in chains, to produce dull mechanical work, but granting them freedom within the limit of subordinating the part to the purposes of the whole. Several examples could be cited. Charing Cross Mansions is a beautiful design, and its central feature, with its many sculptured figures, is a source of pleasure to every one who is sufficiently interested to endeavour to read what the sculptor has expressed. In the new Savings Bank in Ingram Street we have, perhaps, the finest example of the sculptor's art on buildings, which has been executed in Glasgow. Yet it is possible for carving to be too delicate for its place and purpose, and I almost fear that the limit has been overstepped in this case. The use of sculptured figured work has its dangers, and perhaps the greatest danger lies in the readiness with which it may become constructive instead of merely decorative. It can never bring pleasure, but can only call up feelings of pain, to see a small human figure, however exquisitively carved, from one year's end to another, under a great load of stone, represented by a fragment of cornice and pediment. The beautiful tomb of Lorenzo de Medici, executed by Michael Angelo, is graced by sculptured figures amongst the finest the world has seen. Yet the figures could be removed, and the tomb remain; bereft of its greatest charm doubtless, yet still a tomb. In the Sun Buildings in Renfield Street the aid of the sculptor has been sought with the happiest results. In no part has the decoration been allowed, in the very smallest degree, to interfere with the architectural treatment, nor is there any straining for effect. All is quiet and natural. Without the carving, the building would still be fine. With it, it has gained immensely in expressiveness. To those with eyes to see, it must always be a constant source of pleasure, for here, as on a page of stone, we may read the story of the sun as it has come down to us in mythology, and the work, in its execution, has much of the charm and beauty of the Italian masters. There are only three dull spots in the design, and these are the rough panels over the

principal entrance. One feels that it would be conferring a public benefit were Mr. Leiper to carry out, at the earliest, his proposed designs for the twelve months, or other appropriate subject.

It is often maintained that the Gothic style offers greater freedom for design and decorative treatment than any other style of art. It may be doubted, however, if it would be desirable to have more freedom than this Sun Building illustrates, where it is easy to detect the influence of a phase of our Scottish art. Yet there is reason to regret that no example of Gothic work, worthy of the name, has ever been erected in any of our busy streets. It is the case that Gothic is almost always employed amongst us in church building. It is generally felt that this style is most appropriate and best suited to our requirements. Unless we are prepared to admit that religion is but as an outer cloak, donned for a few brief moments once every seven days, and that the emotions springing from all that we associate with religious services have no root in our lives, then we must accept it that there is nothing in the requirements of our work-a-day lives which can make Gothic unfit for our homes and places of business. In a Gothic house, however, it is not necessary that every stick and stone, and every piece of furniture, should blossom into crockets and pinnacles. The home of the cultured and travelled in mediæval times must have been as the home of the cultured and travelled to-day, full of pleasant objects of the most varied styles of art. And so it was in the mediæval churches, for it was the delight of the wealthy travelled churchmen to bring home rich furnishings, the product of other hands in other lands. Of one good old Scots abbot it was written that he "brocht hame mony gud jowellis, and clathis of gold, silver, and silk, and mony gud bukis, and maid staitlie stallis, and glasynnit mekle of all the kirk, and brocht hame the staitliest tabernakle that was in all Scotland, and the maist costlie."

Although it is not in one of our busy streets, we have a beautiful Gothic building in Messrs. Templeton's mill at the Green, and here the design has been so enriched by the use of materials of various colours that one almost longs to have the structure transplanted. The street in which such a building stood would be the most famous street in Glasgow. But, remembering that our city was at one time the home of the open piazza or arcade, the revival of so beautiful a feature might well be attempted. Is not the most fashionable Rue de Rivoli, in Paris, of this design? And it is to be found in other parts of the

Continent—in Liége and Berne, and, best of all, in the Doge's Palace, Venice, where the opportunity was seized for the production of a wealth of sculptured decoration, the interest of which cannot be exhausted by the study of a lifetime.

Reference has been made to the happy results which flow from the combined and sympathetic labours of architect and sculptor. We may anticipate, with confidence, equally happy results from the institution of the closest relationship between the architect and artist painter. Architecture and painting have both suffered immeasurably by the long-continued divorce, for expression can never be adequate, or reach to the highest possible attainment, when it is confined to form, or when the whole environment is not the artist's own creation. The movement towards such a desired union is upon us. Colour, hitherto, has been sought for and found, to a very large extent in glass, and our local work in this material is of the finest. But as windows which admit little or no light make a rich architectural composition a useless extravagance, it is probable that ere long, as in the past, colour will be but faintly suggested in glass, when it is employed at all, and that the richest work of the artist will be found in wall and screen paintings. Already a great opportunity is being prepared in our Municipal Banqueting Hall, and it must be the desire of every citizen that nothing will occur to mar the success of the undertaking. If the most justly celebrated artist is employed—and none other is worthy to be employed by a great city—and if the subjects are carefully and wisely chosen, then everything will have been done that was possible to secure the most perfect results.

In a plea for art in our city it is impossible to overlook the craftsmen, on whose deftness of hand and artistic perception we are dependent for the adequate realisation of our designs. No architect worthy of his calling but must endeavour to maintain an attitude of sympathy and helpfulness towards the workmen engaged under his instructions. Many disappointments, doubtless, will be in store for one actuated by such feelings; and perhaps nothing strikes home more keenly than the consciousness of the pernicious influence of trades unions, combinations of masters, as well as of men, whose sole object is the regulation of hours and wages. It is my own experience that the best workmen—best in intelligence and skill—have but a lukewarm interest in the present unions. An opportune moment may come—and the sooner it comes the better—when these men will discover their own

numbers and their strength, and then we may hope to see our trade guilds revived amongst us, with the only qualifications for admission an honourable life and skill in craftsmanship. But the means for providing an adequate training are sadly wanting in Glasgow, which in technical education lags behind many another town of third or fourth rate importance. And whilst the consideration of how such provision can best be made on broad and adequate lines is put aside, it is to be feared that ill-considered measures are being tried, which, in the end, will prove to be expensive and undesirable.

It is possible, I believe, to differentiate between trades and studies which are purely scientific and those in which art must have a prominent place before the highest attainment is possible. This would indicate that two technical schools are required. Can there be any hesitation in saying that the school in which the industrial arts are taught must be a school of art in the very highest sense, and that the director must be, not the man of science, but the artist, the man of emotions and sympathies, of rare fancies and fresh ideas, one whose word is an inspiration, and whose touch is full of expression? It is a matter of common knowledge that our present-day efforts in craftsmanship lack nothing in the qualities of strength or mechanical finish. What is lacking is the artistic feeling, the perception of beauty in form, which can only come by training, and by the mind realising that beauty lies in perfect adaptation to purpose. This is written with the knowledge that there is a present intention to erect a Corporation School of Art in Glasgow on the old lines, with which we are all more or less familiar. What is wanted is not an art institution ruled from South Kensington, under whose prevailing influence the leisurely amateur and *dilettante* has been encouraged to amble his or her pleasant way, picking up medals as they pass. What is wanted is a great art institution, modelled to our own requirements, where every worker will be encouraged and trained to work in his own craft, and stimulated to the highest efforts; where the worker in stone, or wood, or metal, or glass, or other material, will learn how great a dignity it is to labour, and how great a delight it is to find that treasures lie buried in even the humblest materials. It is impossible to overestimate the power for good in such a school of industrial arts; and not for good alone to art, since it would help to foster self-respect, and would banish the evils which flow from pretence and discontent. The failure to realise the immediate necessity for founding such a school in our midst is inexplicable.

The aim of this paper is the aim of every true citizen—to increase the credit of our native city. Famed for many things, we would have it still more famous as the home of art, and of a people readily touched by its power. Of late years the desire to extend the influence of art has been growing amongst us, and this is perhaps most to be observed in the increased opportunities now afforded to the public for the enjoyment of the best music. Something approaching the sum of £2,500 is now spent annually with this object. It is not desirable to advocate the spending of one penny less, nor should one sweet note be omitted. Only let us not be altogether selfish and forgetful of the future. We know almost nothing of the music of the ancient Grecians. But music they must have had. Yet the legacy they have left in their works in architecture and sculpture has proclaimed to the world how great was their passion for beauty, and the world acclaims the creations of their time as its greatest treasures. We know little or nothing of the music most affected by the peoples of the middle ages what to them took the place of "The Lost Chord" or "The Better Land." But music they must have had. Yet we, their heirs, have good reason to be glad that they loved art so much that they reared those "mountains of light and air," those cathedrals of long aisles and uplifted spires. Let us have music by all means, but do not let us forget that it is a feast from which no fragments remain.

My last thought is for my fellow-artists, and it cannot be better expressed than in the words of the philosopher-poet:—

"Not from a vain or shallow thought
His awful Jove young Phidias brought;
Never from lips of cunning fell
The thrilling Delphic oracle;
Out from the heart of nature rolled
The burdens of the Bible old;
The litanies of nations came,
Like the volcano's tongue of flame,
Up from the burning core below,—
The canticles of love and woe;
The hand that rounded Peter's dome,
And groined the aisles of Christian Rome,
Wrought in a sad sincerity;
Himself from God he could not free;
He builded better than he knew;—
The conscious stone to beauty grew."

III.—ADMISSION OF THE RIGHT HON. LORD KELVIN AS AN HONORARY MEMBER.

THE Second Ordinary Meeting of the Philosophical Society of Glasgow, for Session 1896-97, was held on the evening of Wednesday, 2nd December, 1896, when the business was entirely devoted to the celebration of the Jubilee of Lord Kelvin's membership of the Society.

Dr. Eben. Duncan, President of the Society, occupied the chair, and was supported by Lord Kelvin, Sheriff Berry, Professor Jack, Professor Ferguson, Mr. Henry A. Mavor, and Dr. Freeland Fergus, Hon. Secretary.

After the minute of the last ordinary meeting was approved of, Dr. Fergus intimated apologies for absence from Lord Blythswood, the Lord Provost of Glasgow, the Very Reverend Principal Caird, Sir John Neilson Cuthbertson, Sir William Arrol, Professor M'Kendrick, Dr. J. B. Russell, and others, who all regretted, for various reasons, their inability to be present.

After the admission of three gentlemen as Ordinary Members,

The PRESIDENT said—Ladies and Gentlemen,—The next item on the billet is the admission of the Right Hon. Lord Kelvin as an Honorary Member. He went on to say—My Lord, in the year 1860, on the recommendation of a committee of which you were convener, and on a motion moved by yourself, the Glasgow Philosophical Society elected as Honorary Members a number of men who had obtained a position of pre-eminence in the scientific world, and who had conferred benefits on humanity by extending the boundaries of science. This list we have from time to time revised and added to, and, in doing so, we have been most careful to select only names of men of the highest distinction —names of men who are or have been acknowledged leaders of the scientific thought of the age we live in. By the unanimous vote of the Council and of the Society, I have now the honour to ask your Lordship to allow us to place your name in the list of our Honorary Members, and, in token of your consent, to sign the

roll which you signed fifty years ago when you were elected and admitted an Ordinary Member of the Society.

Lord Kelvin then signed the roll.

The PRESIDENT, resuming, said—My Lord, when in June last the Jubilee celebration of your professorship was held in the University of Glasgow, when representatives of universities, scientific societies, and learned bodies from all parts of the civilised world, were assembled in our city to present their congratulations, and when congratulatory telegrams were pouring in from Africa, Asia, and America, recording the eminent services which your Lordship had rendered by your researches to the progress of science and the cause of humanity, no class of the community could be more cordial in their sympathy with the public rejoicings which then took place than the members of the Glasgow Philosophical Society. When it came to the knowledge of the office-bearers of the Society that, by a happy coincidence, our ordinary meeting, which fell to take place to-night, completed the fiftieth year of your Lordship's membership of the Society, it was unanimously resolved by the Council to celebrate this event in a manner befitting so interesting an occasion. I hold in my hand an extract from the old minute book of the Society, which shows that on Wednesday, 2nd December, 1846, at a meeting of the Philosophical Society, held in the old Andersonian University Buildings, under the chairmanship of the late Mr. Walter Crum, who was at that time Vice-President of the Society, and in the absence of the President, Dr. Thomas Thomson, Mr. William Thomson, B.A., Professor of Natural Philosophy in the Glasgow University, was elected an Ordinary Member, and in this book, containing the roll of members, we have, my Lord, your signature at that date. For fifty years you have been an unwearied worker in this Society. I find, on referring to the old minute book, that in the year 1847, just one year after you joined the Society, you became a member of the Council, and served in that capacity for seven years. In 1856 you were elected President, and served in that capacity for two years. For ten years subsequently you acted as a member of the Council, and again in 1874 you were elected to the Presidential Chair for a period of three years. Since that time you have acted as an Honorary Vice-President of the Society, and as President of the Mathematical and Physical Section of the Society. You have thus rendered continuous services to the Society as an office-bearer for nearly the whole period of your membership. After a careful perusal of

the old minute book, I speak the language of truth, and not of rhetoric, when I say that no member whom the Philosophical Society has now, or ever has had, on its roll has read so many interesting papers, and done so much in the management of its affairs and the promotion of its interests. Of the wider spheres in which you have been so eminently successful I need not, and I shall not, venture to speak. I now call upon the Honorary Secretary, Dr. Fergus, to read the address which has been drawn up by the Council, and which has had the unanimous approval of the Society itself.

Dr. Fergus read the address, which was as follows:—

"To the Right Honourable Lord Kelvin.

"On this the Jubilee of your Lordship's membership of the Philosophical Society of Glasgow, the members of the Society desire to tender to you their cordial greetings and hearty congratulations. They recall with especial pleasure, and with a sense of gratitude, the interest which you have always shown in the well-being of the Society, and the active part which you have taken in its proceedings. You have contributed many important papers to its *Transactions*, and your occupancy of the office of President may be said to have formed an epoch in its history.

"On an occasion such as this it is unnecessary to recount the many services which you have rendered to almost every branch of science—services which have conferred lasting benefits on mankind. The work which you have accomplished has been attended with results of the highest importance to abstract science, and your investigations have all along been conspicuous for their practical utility. Moreover, while the members of the Philosophical Society yield to none in their respect for your eminence and merits as a man of science, they desire also respectfully to express their admiration for you as a man. That peculiar modesty and absence of assumption, which are such marked characteristics of your Lordship, must ever endear you to simple and learned alike. It cannot but be gratifying to you to know that many good and true men, whose very names are necessarily unknown to you, regard you with feelings of filial veneration.

"That your Lordship may be spared for many years to continue your researches is the earnest wish of every member of the Philosophical Society of Glasgow, nor is it less their hope that in these future years your life may be cheered and your labours

lightened by the companionship of Lady Kelvin to preside over your hearth and home.

"Signed on behalf of the Philosophical Society of Glasgow, on this the second day of December, in the year of our Lord, eighteen hundred and ninety-six.

"EBEN. DUNCAN, *President.*
"JOHN MANN, *Hon. Treasurer.*
"FREELAND FERGUS, *Hon. Secretary.*"

The PRESIDENT—On behalf of the Society, my Lord, I have now to ask you to do us the honour of accepting this address, and I may perhaps be allowed to say that it is the earnest wish of the office-bearers and all connected with this Society that in future years, as in the past, we may at times have the privilege and honour of seeing you amongst us.

LORD KELVIN, who was received with applause, said—Mr. President, Officers, and Members of the Philosophical Society of Glasgow,—I thank you all most warmly for your kindness in celebrating the Jubilee of my membership this evening; and for the permanent memorial of the occasion which it is your intention to place in the habitation of the Society. You recall happily to my memory the evening of Wednesday, the 2nd of December, 1846, within a month of my entrance on the duties of my professorship in the University, when, at a meeting of the Philosophical Society, with Walter Crum, Vice-President, in the Chair, I had the honour of being elected a member. During the fifty years, completed this evening, I have benefited largely and in many ways by my membership. In attending ordinary meetings of the Society, and from personal intercourse with its members, I have gained much interesting knowledge and many valuable suggestions. Many of my own earliest scientific efforts met with a friendly and encouraging welcome, and the volumes of the Society's *Proceedings* have given permanent record to papers which I have offered. The kindness which, as Ordinary Member, as Member of Council, as President, and as Honorary Vice-President, I have received from the Philosophical Society during these fifty years, has been unfailing, and the memory of it is, I assure you, exceedingly valuable to me. I am deeply touched by the kind words which you, Sir, in the name of the Society, have addressed to me this evening. For these, and for your con-

gratulations on my Jubilee, and for your good wishes for Lady Kelvin and myself, I thank you with all my heart.

The PRESIDENT—I have now to call on Mr. Mavor to address us.

Mr. HENRY A. MAVOR said—Mr. President and Members of the Glasgow Philosophical Society,—It is my delightful duty, on behalf of the subscribers, to present to you this evening this bust of Lord Kelvin. (Mr. Mavor then unveiled the bust.) To trace to its source the idea now so happily consummated would involve a study of a primordial instinct of the human race, one which we are told lies at the base of so great a superstructure as that of theology itself, while others quote the high authority of the second commandment for condemning it as a crime. I am afraid that the subscribers to this bust must admit the possession of this instinct which has resulted in this effigy of Lord Kelvin. By some virtue we place ourselves in your hands, and ask you to accept of this bust and give it a place in your rooms. It is long ago since you discovered that a sage dwelt among you. I think that the Philosophical Society discovered the fact before the outside world did, and after our prophet has found much honour in other countries he may well return to his own country to receive one more laurel, and to see his effigy in the place of honour. Glasgow has had soldiers and travellers whose memory it has delighted to glory in, but there are other ways of making a man's brain-pan dirl than by striking it with a club, and Lord Kelvin knows well how to use weapons which stir the brain even beyond the stage when the excitation produces a pleasurable ferment in the nerve centres. These are the weapons that philosophers delight in, and therefore I think we may ask you to accept this portrait-bust of a man who, while he lives, knows what a gift life is, and who has written his name on the roll of science. We shall, by preserving this bust, earn the gratitude of the future time when Lord Kelvin's work has received its permanent place in the structure of human knowledge. But while the future alone can give Lord Kelvin's work its proper place, it is given to us to do personal homage, not only to the greatest scientist of our century, but to the kindest and truest knight who sits among his peers peerless.

The PRESIDENT—Mr. Mavor, Ladies, and Gentlemen,—On behalf of the Society, I have to thank Mr. Mavor and the subscribers to the bust fund for the very handsome present they have made to the Philosophical Society, On behalf of the Society, I may say

that it is one of the best gifts that we could possibly have received from any quarter. I am sure it will be kept as one of our most cherished possessions, and that, for many future generations, it will adorn the rooms of this Society, and be an incentive to the younger generations of scientists, who are always arising amongst us. I have now to call upon Professor Jack to address us.

Professor JACK—Mr. President, Ladies, and Gentlemen,—I have a pleasing duty imposed upon me, to ask Lady Kelvin to accept of the replica of this bust for her own home. (Professor Jack unveiled the replica.) Such a motion requires no word of apology or justification, but perhaps there has been no instance in which such a motion has been proposed in which the justification is more complete. No scientific man who has had the privilege of knowing Lord and Lady Kelvin in private can ever fail in the gratitude which he owes to her for what she has done for him and for his work. During nearly a quarter of a century she has, with constant care, prevented the access to him of all those little worries and distractions which do so much to waste energy and to use up vital force. Her interest and her sympathy, not only in the practical work in which Lord Kelvin has been engaged, but in the scientific and abstract work in which he has been engaged, have probably done more to help him than anybody but Lord Kelvin himself can tell. I am quite certain, also, that the brightness and variety of the home interests with which Lady Kelvin has surrounded his life have done a great deal to prevent what happens even to the greatest thinkers sometimes—to prevent that sense of weariness and exhaustion which deprives them, from time to time, of a little of the elasticity which naturally belongs to them. I have, on behalf of the Society, to ask Lady Kelvin to accept the replica of the bust which is now before the Society; and to add that I believe that the Society is paying not only a graceful but a just tribute to one who has been, during all those years Lord Kelvin's principal assistant and helper.

Lord KELVIN—On behalf of Lady Kelvin, I desire to express her hearty thanks for your kindness in presenting to her the replica of the bust which you have honoured with a place in this hall, and I am quite sure that she will treasure it as a permanent memorial of your kindness to myself this evening, and as an indication of your large appreciation of what she has done for

me. I thank you, Professor Jack, with my whole heart, most warmly, for the kind words which you have used in what you have just now done in presenting this replica to Lady Kelvin. No one can feel more than I do the truth of all you have said, and I am deeply sensible of it.

The PRESIDENT—I have now to call on Mr. Munro to address us on behalf of the electrical engineers of the city.

Mr. J. M. M. MUNRO—My Lord, Ladies, and Gentlemen,—In this year, when all the world has agreed to do honour to our greatest citizen, it is a reasonable thing that the electrical engineers of this city should aspire to join in the chorus of congratulation. The Institution of Electrical Engineers has, as a body, already done homage to the name and fame of Lord Kelvin in this his jubilee year, but those who are his fellow-citizens engaged in that industry which he has done so much to create, and seeing and hearing him more frequently than others, feel for him a measure of personal affection which demanded a more personal expression. This address which, in conventional form, imperfectly expresses our esteem and regard, was signed by the representatives of nearly every electrical engineering establishment in Glasgow. I had hoped that Mr. Arnot, the official representing the city, would have been here to-night to perform this task, but, in his unavoidable absence, I am proud to perform the duty. Will you permit me then to read to you this address, and may I ask you, Lord Kelvin, to do us the great honour to accept of it?

ADDRESS TO THE RIGHT HONOURABLE LORD KELVIN, LL.D., D.C.L., F.R.S.

We, who are engaged in Glasgow in the profession and business of electrical engineering, desire, in this jubilee year of your professorship and sixty-fourth year of your residence in our city, to add our congratulations to those which you have already received, and will still receive, from all parts of the world.

During these years in which you have added to the lustre of our university and city, your mathematical and inventive genius has been applied with the most brilliant results to the increase of man's insight into, and control over, nature, and your name will be always associated with those great discoveries in physical science which will make this century ever memorable in the history of mankind.

We desire especially to acknowledge the services which you have rendered to the industry in which we are ourselves engaged.

When commerce and the development of modern manufactures needed improved means of communication with all parts of the world, you perfected the ancient mariner's compass and sounding lead, and you made ocean telegraphy possible by your researches into the laws governing the transmission of electrical impulses, and by your inventions of the mirror galvanometer and siphon recorder.

When engineering problems became urgent and important, you assisted pre-eminently in the elucidation of the nature and correlation of the various forms of energy, and in the clear statement of the physical facts upon which all mechanical structure and movement are based. When electrical engineering became an industry, you early recognised the outstanding importance of exact measurement, and you have designed and prepared a series of electrical measuring instruments of extreme accuracy.

It would, however, be idle, as it is unnecessary, to attempt to catalogue the many ways in which you have helped to found and foster the modern profession of electrical engineering. In almost every one of its fields we have reaped where you have sown.

It is not the least of your claims to our consideration and respect that in this profession and business of electrical engineering you are one of ourselves, and have in this city shown us so perfect an illustration of how to combine scientific knowledge and accuracy with manufacturing and commercial ability.

Our sincere wish is that you may continue to see many happy days, and live to tell us what electricity is, and to discover yet many more methods by which electrical energy may add to the comforts and conveniences of mankind.

Signed, on behalf of the Electrical Engineers of Glasgow,

J. M. M. MUNRO.

LORD KELVIN—Mr. President, Mr. Munro, Ladies, and Gentlemen,—I desire, Mr. Munro, to convey to our brother electrical engineers in Glasgow my warm thanks for the honour they have done me and for the great pleasure they have given me in the presentation of this address. I feel keenly indeed the pleasure of being thus spoken of by those who are engaged in electrical engineering in this city. We all have pleasure in our work, and

I believe that a primary reason for the existence of electrical engineers is the extreme attractiveness of the work that has been opened out to men in respect of the applications of electricity for the good of mankind and in aid of general engineering. I have taken a very great pleasure from my earliest years not only in the mathematical theory of electricity and electrical experiment, but also in all applications of electricity to practical purposes. I can only say that, in your kindness, I think you have over-estimated the value of what I have done, but I take the expression, as I am sure it is meant, as thoroughly sincere. I feel conscious of how very far short, indeed, of what might have been done, is all that I have been able to do to help my fellow-workers in this field. I thank you very heartily for your appreciation of what I have done, and for the kind expressions contained in the address.

The PRESIDENT—I have now to call upon Dr. Fergus to address us.

Dr. FERGUS—Mr. President, Ladies, and Gentlemen,—The duty which has been assigned to me is a light one, and also a very pleasing one. I rise to propose that the very best thanks of the Glasgow Philosophical Society be given to Mr. Shannan, the artist who has carried out the work which you have seen unveiled to-night. At the time of the selection of the artist, I happened to be in charge of the Bust Committee during the temporary absence of our friend, Mr. Mavor, and it was our duty to make a careful selection, for we felt the importance of the work. It became necessary, above all, that we should transmit to posterity an accurate likeness of our distinguished member. We carefully went through the studios of various artists, and took a vote by ballot. That vote was almost unanimously in favour of Mr. Shannan, and I think, from the excellence of those busts which you see to-night, that there can be no doubt that our selection was an exceedingly fortunate one, and that Mr. Shannan has done his work remarkably well. No doubt, Sir, our primary object in having this work executed was to do all possible honour to Lord Kelvin—on that we were of one mind and opinion;—but in a certain sense our object was a somewhat selfish one. We wanted to possess a good portrait for ourselves, and I for one personally felt that we were asking a great deal when we asked Lord Kelvin to give sufficient time for the sittings necessary for this work. We know what extreme value Lord Kelvin puts upon time. I do not think that there is a harder-working man than he is, and I felt

that we were taking a great liberty in asking him to give twelve or thirteen sittings to a sculptor. I think his Lordship will bear me out when I say that Mr. Shannan has accomplished his task with little inconvenience to his distinguished sitter. On these grounds the Philosophical Society may well bestow upon him its best thanks for the manner in which he has accomplished his task.

Mr. SHANNAN—Mr. President, Ladies, and Gentlemen,—I have to thank you for the very kind appreciation of my work.

The PRESIDENT—I have now to call on Sheriff Berry.

Sheriff BERRY—Mr. President, Ladies, and Gentlemen,—Although not a member of the Philosophical Society, and, perhaps to some extent, fittingly because I am not a member, I have been unexpectedly asked to take a part in this evening's proceedings. I have had the privilege to be enabled to do so and to be present here, although it may be that the part I have to perform is really a very subordinate one. Still it is a very necessary part, and that is to ask you to accord a vote of thanks to the subscribers to this bust which has been disclosed and presented to this Society. To all of us who are here present, it is a most interesting occasion to take part in the presentation of this bust to one who has been fittingly described as the most distinguished citizen of Glasgow, and to myself, in particular, it is a very agreeable event in my life, seeing that there are few in this meeting who are privileged to call themselves older friends of Lord Kelvin than I. I knew him before he was a professor in the University, and I remember to this day many acts of kindness which I received from him at an early part of his life and mine. I can only say, as I have said, that I deem it a privilege to be allowed to propose a vote of thanks to the subscribers to this bust.

Professor FERGUSON—Mr. President, Ladies, and Gentlemen,—I have been called unexpectedly to reply to this vote of thanks, and I can only say that I do not see very well what I have to reply to. The bust having to be got, we were only too delighted to subscribe. The pleasure is ours in having it done, and seeing it done so successfully, and our reward is, we gratefully acknowledge, in having it before us to look at. It is the success of the committee's work which is our reward, and I think the subscribers are very thankful indeed that they have had the opportunity of subscribing in order to get such a valuable piece of work made permanently the property of the Society. I think that if the subscribers feel as I do, we have hardly anything to

be grateful for, except for the privilege of subscribing. I have much pleasure in returning thanks to the Society for the vote of thanks that has been accorded to us.

Professor RAMSAY—I have the honour to propose, on your behalf and on my own, a vote of thanks to the President for presiding to-night. Your thanks have been expressed sufficiently in your faces, but allow me to add my extreme obligation to the President in being allowed to be present here to-night. I had the great misfortune, through no fault of my own, to be obliged involuntarily to be absent from the Jubilee of Lord Kelvin, a fact which I regret very much, and I rejoice in being present here to-night at what is a kind of reflection of the Jubilee, and to be able to say with what intense feelings of respect, love, and admiration, as a friend and colleague, I have regarded Lord and Lady Kelvin. I beg to offer my heartiest thanks to the President for allowing me to be present on this most interesting occasion, and I ask you to accord a hearty vote of thanks to him for presiding to-night.

The meeting then separated, and met again in the library, where tea and coffee were provided.

IV.—*The Pollution of Scottish Rivers.* By JOHN GLAISTER, M.D., F.F.P.S.G., D.P.H.(Camb.), &c., Professor of Forensic Medicine and Public Health, St. Mungo's College, President of the Sanitary and Social Economy Section.

PRESIDENTIAL ADDRESS.

[Delivered to the Society, 6th January, 1897.]

THE adaptability of our natural water-ways for the reception of the waste products of man and his works has brought about a serious condition of pollution therein, more particularly during the present century, owing to the enormous development in processes of trade, and to the establishment in our populous centres of the water-borne system of sewage. Except it be where nature still reigns in its original primitiveness and grandeur, it cannot be said that a single river in any county of Scotland, where masses of population are segregated together, is in a state of even comparative purity; indeed, in these circumstances, they are more likely to be fouled to a very considerable extent; and those waters in which fish formerly abounded, which could be used with benefit to the health of both man and beast, and which in their pellucid character were a source of beauty and a joy to the eye, are now changed into waters of varying hue not found in nature, often dark, grimy, and slimy, with silted beds and heaped-up banks, composed of all manner of foreign material, always unpleasant to see, and sometimes unpleasantly odorous.

The utilitarian deems a water-course as the natural channel for all kinds of products, and the poetry of a sparkling river does not appeal to him; he appears to care little if he can but send his polluted discharges away from himself, and less as to what is to become of the water supply of his neighbour down stream. The lover of nature, on the other hand, bewails the unhallowed use which is made of our streams, and he, in consequence, is apt to

swing his pendulum too far against the progress of man in manufacture. Between these two extremists, however, there is a reasonable middle position to hold for the man who desires that nature's works should be left as nearly as nature made them, compatible with the advancement of manufacture, and the health and comfort of the people. He deplores that, by reason of the polluted character of our streams, the natural water supplies of the country have been ruined, and that, in consequence, cities and towns, compelled to abandon the use of such waters, have had to seek still unpolluted natural supplies for their use, often at great cost and trouble. If we take Glasgow as a case in point, we find that between the years 1806 and 1859 the bulk of the water supply was obtained from the Clyde, near Dalmarnock, and that advancing pollution was one of the chief factors in determining that a new supply should be obtained from Loch Katrine. And what is true of Glasgow is equally true for many other places. Nothing occurs more prominently in the history of our rivers than that their waters, formerly usable for domestic purposes, have had to be rejected on this account, and that a time came when, indeed, they could not be used even by animals, so polluted and offensive had they become. This evil became so serious that even Parliament became alarmed, in consequence of which a Royal Commission was appointed in 1868 "to inquire into the best means of preventing the pollution of rivers," which Commission, after years of exhaustive labours on the streams of the United Kingdom, concluded their work for Scotland in the following important statement:—"We are convinced that the thing of immediate and imperative importance in connection with river improvement throughout the country is simply the prohibition, under adequate penalties, of the gross pollution which at present renders so much of the running water of this country useless both to the manufacturer and the agriculturist." (Fourth Report, Vol. I., p. 156.) Nothing less strong than this could have been expected from those who had to "inspect and record examples of river pollution of nearly every kind to be met with in Great Britain, and of every degree of intensity between the slightest departure from the purity of the original rain water and a filthiness offensive to almost every sense, and destructive of nearly every use to which water can be put."

The chief pollutions, one or more of which is likely to be found in nearly every river, may be divided into three classes, viz.:—(1)

Solid matters; (2) sewage or other excrementitious or putrescent refuse; and (3) liquid discharges from manufacturing and trade processes.

It is only necessary to say something regarding the manufactures from which the last come, and the character of the discharges. Taken at random, the following trade processes may be held as typical, and they will illustrate wherein the harmful or polluting effects of their discharges consist, namely, woollen mills, tanneries, dye works, gas works, chemical works generally, bleach works, paraffin-oil works, distilleries, paper mills, jute and linen works, starch works, sugar refining, and calico print works. In most of these, chemicals of various kinds are used, some of which are plentifully found in the effluent discharges. These very frequently consist of alkalies or acids, and sometimes contain arsenic, or other poisonous metals, in chemical combination. The dye-stuffs which are used in various industries also impart a variety of colours to the effluents, which, in turn, discolour and disfigure the water in the stream. From certain chemical works the discharges are not only offensive to the eye, but also to the sense of smell; such are likely to be found from paraffin-oil works, gas works, and from chemical works where sulphuric acid is made. We have omitted, intentionally, from the above list the pollution from coal-washing, which is a trade development since the Commission reported, and which, in these days, contributes so much, and in so many places, to the pollution of our streams. These, therefore, may be deemed sufficient to demonstrate the range of pollutions and the incidence of their harmfulness.

As a consequence of the work of the Rivers Pollution Commission, the Rivers Pollution Prevention Act was passed into law in 1876. But it cannot be considered, as expressing in their entirety the views entertained by that Commission, to be a reflex of the means for the prevention of pollution thought to be necessary by the Commission, inasmuch as it left out any standard by which any effluent could be considered fit or unfit to be passed into a stream, and any penalties for contravention of its provisions. Of this we shall require to say something further at a later stage; suffice it to say here, that the omission of such a standard and such penalties have been, and are, deemed by many to be fatal blots in the provisions of the Act.

It will be necessary, to carry you with me, that something should now be said of the provisions of that Act, in order that the

description of what follows at a later stage of the address may be more intelligently understood.

The following, therefore, are its salient points, grouped as in the order of parts in the Act itself :—

The Rivers Pollution Prevention Act, 1876, consists essentially of the following prohibitory clauses,—namely,

"1° No person shall put, or cause to be put, or to fall, or shall unwittingly or knowingly permit to be put or to fall, or to be carried into any stream, so as to interfere with its due flow, or to pollute its waters—

Solid Matters. Part I. "(*a*) The solid refuse of any manufactory, manufacturing process, or quarry, or any rubbish or cinders, or any other waste, or any putrid solid matter;

Sewage Pollutions. Part II. "(*b*) Any solid or liquid sewage matter (unless he shows to the satisfaction of the Court that he is using the best practicable and available means to render such sewage matter harmless);

Part III. "(*c*) Any poisonous, noxious, or polluting liquid proceeding from any factory or manufacturing process; and

" "(*d*) Any solid matter from any mine in such quantities as to prejudicially interfere with its due flow, or any poisonous, noxious, or polluting solid or liquid matter proceeding from any mine, other than water drained or raised from the mine (unless, &c., as in *b*)."

The object of the Act is—

"To make further provision for the prevention of the pollution of rivers, and, in particular, to prevent the establishment of new sources of pollution.

Prosecuting Authority. "Unless and until Parliament otherwise provides, the following enactments shall take effect :—'Proceedings shall not be taken against any person under this part of this Act, *save by a sanitary authority*, nor shall any such proceedings be taken without the consent of the Local Government Board;' provided always that, if the sanitary authority, on the application of any person interested alleging an offence to have been committed, shall refuse to take proceedings or apply for the consent by this section provided, the person so interested may apply to the Local Government Board, and if that Board, on inquiry, is of opinion that the sanitary authority should take proceedings, they may direct the sanitary authority accordingly, who shall thereupon commence proceedings."

The conditions upon which consent of Local Government Board is to be given are the following :—

"(1) Regard must be given to the industrial interests involved in the case, and to the circumstances and requirements of the locality.

"(2) Consent shall not be given by the Board 'to proceedings by the sanitary authority of any district which is the seat of any manufacturing industry, unless they are satisfied, after due inquiry, that means for rendering harmless the poisonous, noxious, or polluting liquids, &c., are reasonably practicable and available under all the circumstances of the case, and that no material injury will be inflicted by such proceedings on the interests of such industry ;'

"(3) Any person against whom proceedings are proposed to be taken shall, notwithstanding the consent of the Board, be at liberty to object before the sanitary authority to proceedings being taken, and the authority shall, if required in writing by the said person, afford him an opportunity of being heard against such proceedings being taken, so far as the same relates to his works or manufacturing process. The authority shall thereupon allow said person to be heard by himself, agents, and witnesses, and, after inquiry, the authority shall determine, having regard to the considerations laid down for the obtaining of consent of the Local Government Board, whether the proceedings shall still proceed, or shall cease and determine.

"Where one sanitary authority takes proceedings against an offender, it shall not be competent for another sanitary authority to take action against the same person till such reasonable time has elapsed wherein the offender might carry out the order of a competent Court."

The Act further provides :—

(1) That every sanitary or local authority having sewers under their control shall give facilities for enabling manufacturers to empty their waste products into such sewers, except such products as would prejudicially affect the sewers, or the sale, application to land, or otherwise, of the sewage matter conveyed in the sewers, or which would, from its temperature, or otherwise, be injurious in a sanitary point of view; or where said sewers are only just adequate for the needs of the sanitary or local authority.

(2) Every sanitary authority, subject to the restrictions named, shall have power to enforce the provisions of this Act in relation to any stream being within, passing through, or by, any part of their district, and to institute proceedings in respect of any offence under this Act against any other sanitary authority or person, whether said offence is committed within or without the district of the prosecuting authority.

(3) Proceedings may also, subject to the restrictions named, be instituted in respect of an offence under this Act by any person aggrieved by the commission of such offence.

Legal Proceedings. "A competent Court of jurisdiction may,

Proceedings shall not be taken for any offence until the expiry of two months after written notice of the intention to proceed has been given to the offender.

"(1) by summary order, require the offender to abstain from the commission of the offence, or to perform his duty where the offence is due to omission of performance of said duty; or

"(2) it may insert in any order such conditions as to time or mode of action as it may think fit, and generally may give such directions for carrying said order into effect as may seem meet; or

"(3) it may remit to skilled parties to report on the 'best practicable and available means,' the nature and cost of works and apparatus required."

A certificate by an inspector of "proper qualifications" appointed for the purposes of this Act by the Local Government Board, to the effect that the means used to prevent pollution from any of the aforesaid causes are the best or only practicable and available means under the circumstances of the particular case, shall be held in all legal proceedings to be conclusive evidence of the fact, and such certificate shall run for a period of two years.

Nothing in this Act shall prejudice or affect any rights or interests existing or vested in any person or persons by Act of Parliament, law, or custom; and nothing in this Act shall legalise any act or default which would but for this Act be deemed to be a nuisance, or otherwise contrary to law.

Besides, "where any local authority or any urban or rural sanitary authority has been empowered or required by any Act of Parliament to carry any sewage into the sea or any tidal waters, nothing done by such authority in pursuance of such enactment shall be deemed an offence against this Act."

Definitions. "*Stream*" includes the sea to such extent, and tidal waters to such point, as may, after local inquiry and on sanitary grounds, be determined by the Local Government Board, rivers, streams, canals, lakes, water-courses, other than water-courses at the passing of this Act mainly used as sewers,

and emptying directly into the sea, or tidal waters which have not been determined to be streams.

"*Solid Matter*" "shall not include particles of matter in suspension in water."

"*Polluting*" "shall not include innocuous discolouration."

This Act has now been in operation for twenty years, or, rather, its provisions were capable of being operated upon for that period. During fourteen of these years the authorities in whom its powers were vested were the local authorities as defined by the Public Health Scotland Act, 1867. The lethargy of these authorities on sanitary matters generally needs only to be mentioned, and the putting into operation of this Act was the rarest possible occurrence. Consequently, when, on the passing of the Local Government (Scotland) Act, in 1889, the powers of the Act became also vested in the newly-created County Councils, they fell heir to a very unenviable legacy in the form of polluted rivers, that even to contemplate the possibility of remedying which made the boldest of Councils pause. Since that date much in the way of remedy could not be looked for, although it is pleasing to record the fact that many of the Councils are alive to the evil, and some are active towards finding a remedy.

A quarter of a century has now elapsed since the Rivers Commission took evidence upon and inquired into the condition of the rivers of Scotland. It will therefore prove an instructive object lesson to compare the condition of our rivers to-day with that of the earlier period, and in the face of an Act of Parliament specially passed for the purpose of preventing such pollution.

It will be sufficient if our attention be confined to the water-courses of the principal industrial counties of Scotland. I am enabled to do this from a special inquiry made for the purpose of this address, in which I have been largely assisted by the co-operation of the Medical Officers of Health of Scotland, to whom I now acknowledge my indebtedness.

Argyllshire.

It is reported from this county that "the pollution of streams is not a question of urgent importance. There are no inland villages or works to pollute streams."

BERWICKSHIRE.

The principal streams of this county are the Blackadder, Whitadder, Leader, and others.

In 1870 it was reported to the Commission that the Whitadder was considerably polluted by the trade refuse from Chirnside Paper Mills, and that it was the source of the water supply of riparian dwellers. (Fourth Report, Vol. II., Part III., pp. 212 *et seq.*)

In 1895 the annual report of the Medical Officer of Health contained the following:—"The principal streams, no doubt, are polluted, less or more, by sewage and woollen and paper mills, but these do not constitute the potable water supply of the inhabitants. At certain of the principal mills precipitating tanks and other processes have been adopted for preventing the pollution of the streams. . . . To interfere unnecessarily with the mills would seriously injure the industry of the locality, which, of course, should be avoided if possible."

At the woollen and paper mills there is an attempt made to prevent pollution, but the tanks into which the refuse proceeds are emptied into the streams when in flood, and thus cause much pollution. It may, therefore, be concluded that little has been done since the Commission sat to permanently remedy the evil.

AYRSHIRE.

The Commission sat in Kilmarnock in 1870 to hear evidence of pollution as it existed in Ayrshire (*vide* Fourth Report, Vol. II., Part III., pp. 291 *et seq.*), and particularly with reference to the River Irvine and the Kilmarnock Water. The latter stream was shown then to be in a state of filthiness absolutely deplorable from sewage and trade refuse, and on its junction with the Irvine it seriously polluted that stream also, in addition to the pollutions which it received before the confluence.

In 1896 these streams are as largely, if not indeed more, polluted than in 1870. The Irvine still receives the sewage of farms along its whole course, and of Darvel, Newmilns, and Galston. The Kilmarnock Water is as grossly polluted as ever, as highly offensive to sight and smell; in short, it is a noisome ditch; and it continues to pollute the Irvine Water as before.

The third annual report of the Medical Officer of Health (1893) contains the following analyses of these streams, and they indicate better than a long description how far Kilmarnock

contributes to the foregoing pollutions. The table is self-explanatory :—

Chemical Composition (in grains per gallon).	Kilmarnock Water.		River Irvine.	
	Above Town.	Below Town.	Above Town.	Below Town.
Total Solids, in solution,	6·72	33·32	21·84	24·92
Chlorine, ...	·98	2·45	1·12	2·38
Nitric Acid, ...	·04	·07	·04	·07
Free NH_3, ...	·002	·600	·007	·560
Albuminoid NH_3, ...	·010	·122	·012	·146
Organic Matter, in terms of Oxygen, ...	·20	·78	·24	·80
Total Solids, in suspension,	·20	9·52	·15	10·92
Organic ,, ,,	·10	8·68	·10	9·80
Mineral ,, ,,	·10	·84	·05	1·12

It may be said, in addition, that the water of the Kilmarnock Burn before it reaches the town would, after adequate filtration, be fit for primary purposes; but that below Kilmarnock, and at a point fifty yards above its confluence with the Irvine, it has become filthy in appearance, due to a large quantity of black sediment, which has a strong odour of sewage. In like manner the water of the Irvine above Kilmarnock might be made usable for primary purposes; below the town, it is grossly polluted.

Among the other important streams of this county are the Garnock, the Ayr, the Doon, the Girvan, and the Stinchar. The first receives a considerable amount of sewage from Kilbirnie, Dalry, and Kilwinning, and the others are also polluted with sewage, but to a much less degree. Kilbirnie Loch was the subject of serious chemical pollution by chemical works on its banks, but this is now prevented.

Chemical waste products and waste-dye liquors also pollute some of the minor streams, while coal-washing and *irony* water pollute others.

The Rye—a tributary of the Garnock—is polluted by the alkaline soapy discharges from a blanket manufactory. Dye works pollute the Rowbank Burn, near Beith, and the Annick Water,

below Stewarton; and although certain measures have been taken to prevent the entrance of the crude waste dye and chemical liquors into those streams, they would appear to be quite inadequate for this purpose. Farmers have complained that some of their cattle have been poisoned by drinking of those polluted waters; indeed, the wonder is that cattle partake at all, unless it be that it is their sole source of supply.

From the manufacture of sulphate of ammonia and other by-products in the Dalmellington and Lugar Iron Works, disastrous results have been produced in the Doon and Lugar Water.

During 1893 wholesale poisoning of fish occurred upon two occasions in the former river, and on a smaller scale upon one occasion in the latter. Provisions have been made at both of these works to prevent the recurrence of such a possibility, and it is difficult to think that anything but gross carelessness could account for the introduction into these rivers of such poisonous pollutants.

Coal-washing products seriously pollute some of the smaller streams, notably (1) the Kerse Burn, in the Parish of Coylton; and (2) the upper reaches of the Nith. In the early part of December the Nith, at New Cumnock, was running black. In like manner, water from ironstone mines, containing iron salts in solution, which, on exposure to the air, become converted into carbonate and hydrated oxide, and thus impart to the water a yellowish red or ochrey colour, becomes a visible pollutant. This, however, if pumped from the mine in this condition, is not a pollution in terms of the Rivers Pollution Act.

DUNBARTONSHIRE.

In the Fourth Report of the Commission (Vol. II., Part IV., pp. 377 *et seq.*) may be found a mass of evidence showing that the Leven was then grossly polluted, mainly from chemical and dye refuse of works on its banks, and, also, a most exhaustive report of experiments made upon fish, &c., in connection with these discharges by the late Professor Penny and by Dr. James Adams, of this city. In the statement made by the agent for Sir James Colquhoun in 1870 to the Commission, he said:—"While the works are in full operation, the escapes therefrom cause the river to be dyed all the colours of the rainbow, but when there is a cessation of labour, such as on a holiday, Saturday afternoon, or Sunday, the water becomes perfectly clear."

It appears also from the same statement that in 1791 bonds were taken from the parties who began printing on the river banks, in which they bound themselves not to pollute the river by their operations. This obligation was violated when turkey-red dyeing commenced, and the pollution prevailed to such an extent that in 1821 legal steps had to be taken to compel the implement of these obligations. This had a temporary beneficial effect. But by 1846 the pollution again had become so bad that legal measures had to be taken under these bonds to compel the polluters to erect filtering apparatus, but these were stayed on promises being made that such erections would be made voluntarily by the owners of the works.

In the second annual report of the Medical Officer of Health (1892) pp. 16 *et seq.*, it is said of the Leven that the red-dye disfigures the river and its banks and the shingle, and interferes with the usefulness of the water for those lower down, and for domestic washing purposes. The chief polluting matters are chlorine, waste-colouring matters, and solid, and partly solid refuse. Mr. Fletcher, the Government Inspector under the Rivers Pollution Act, reported in 1889 to the Secretary for Scotland that the principal pollutants might, in the main, be removed by efficient settling ponds.

Notwithstanding that in certain of these works such settling ponds were erected, the pollution has continued to go on up till the present day. Indeed, in the present year, it has been reported to the County Council—who are acting with praiseworthy energy in the matter—that the provision of filter tanks and beds are not adequate, and that the effluents therefrom are by no means free of alizarine dye, although the amount of chlorine hitherto discharged into the river has been appreciably reduced. At the same time pollution goes on from other works, which is neither "necessary nor justifiable," and the County Council are in the position of either ceasing their efforts in the direction of further purification, or of enforcing the provisions of the Rivers Pollution Acts. This year an alternative project has been suggested, namely, to carry all the effluents from trade processes, by means of piping, to the low-lying ground at the south of Dalquhurn Works. From a report which has been made by an engineer, expert in these matters, it is estimated that about 34 per cent. of the water which passes from Loch Lomond into the Leven is drawn off by these works for trade uses, and that about seven-tenths of that

percentage is so polluted during its use in the works that it would require special treatment before it could be permitted to return to the river as an allowable effluent.

So much for progress in a quarter of a century.

Of the other streams in the county, the Kelvin and the Luggie are notoriously polluted with coal-washings and other trade refuse—the former giving the streams a black appearance, and causing deposits of coaly substance on their banks and in their beds. The sewage of Kilsyth (although treated by irrigation) contributes to the foulness.

Yoker Burn and its tributaries receive the sewage of Bearsden and of smaller populous places on their banks; and Knightswood Burn, the sewage of Knightswood Hospital, of Knightswood, Netherton, and Temple, and the chemical refuse from creosote works, which latter especially makes the water unfit for cattle drinking. Whiteinch Burn is a common sewer.

Probably one of the most praiseworthy steps recently taken by this Council is in respect to the condition of the Gareloch, which is polluted by sewage from the training ship, with 400 boys on board, from vessels anchored in or plying on the loch, from houses on shore, and from the polluted water of the Clyde estuary.

The Council, in terms of the Rivers Pollution Act, approached Sir George Trevelyan—then Secretary for Scotland—to declare the Gareloch to be a "stream" in the sense of the Act, which he did, after an elaborate report had been made by the Rivers Pollution Committee of that County Council of the extent and incidence of the pollution. In accordance with the powers conferred upon County Councils in Section 57 of the Local Government (Scotland) Act, 1889, the County Council have drawn up a series of bye-laws in reference to the Gareloch, which will be submitted for the approval of the Secretary for Scotland, and of which the following is essentially a summary:—

Pollution of Gareloch.—Suggested Bye-laws.

1. If any person, without lawful excuse, puts any manure, ashes, garden or other refuse or rubbish, or any offensive matter, whether solid or liquid, into the Gareloch or upon its foreshores, or upon the bank of any tributary thereof, so that any of the foregoing may be drained, blown, or passed into the Gareloch, shall be liable to a penalty for every such offence not exceeding £5.

2. If any person, without lawful excuse, unloads, stores, or puts, or causes or suffers to fall, any substance used as ballast, or bedding, or

excrement, human or animal, or manure, or stores, ashes, mud, dirt, soil, rubbish, or any refuse material, whether solid or liquid, into the said Gareloch, &c., shall be liable to a like penalty.

3. The owners of all dwelling-houses, dairies, stables, schools, factories, public works, or other premises draining into the Gareloch, &c., shall provide, to the satisfaction of the County Council or local authority, or their officers, such catchpits or filters, or other works as may be reasonably necessary to prevent or diminish pollution of the Gareloch. Such works to be carried out within three months after due notice has been given, failing which the owner to be liable to a penalty not exceeding 20s. per day so long as the default continues, and the County Council or local authority may thereupon carry out such works at the cost of the said defaulter. Appeal to the Sheriff of the County is afforded, whose decision shall be final.

4. Every owner or occupier of premises shall maintain the said catchpits or filters in good order and in efficient condition, to the satisfaction of the officers of the County Council or local authority, failing which the offender shall be liable to a penalty not exceeding £5. Appeal is allowed to the Sheriff.

5. Every drain or pipe whereby sewage, slop water, or other polluting liquid is conveyed into the Gareloch shall, within three months after due notice, be extended so that it shall terminate under low-water mark. All such pipes and drains to be laid to the satisfaction of the officers of the County Council or local authority; failing which the necessary works may be carried out by the County Council and local authority, and the cost charged to the defaulter.

6. No drain or pipe conveying such polluting liquids as the foregoing shall be allowed to discharge the same into any stream or tributary of the Gareloch, and existing pipes or drains so discharging, shall within three months after due notice, cease so to do.

7. For the purpose of giving effect to these bye-laws, the County Council or local authority or their officers may, between nine of the forenoon and six of the afternoon, enter upon any land or premises for the purpose of examining and laying open the same. Refusal of entrance, upon a complaint being lodged by any officer of the County Council or local authority in any Court of summary jurisdiction, shall be overcome by an order of the said Court, under a penalty of £5.

The County Council or local authority to make good any laying open of lands or premises by restoring them, as near as may be, to their original condition; and compensation shall be made when, after such examination, no default lies on the person whose lands or premises have been so invaded.

In like manner, vessels in the waters of the Gareloch may be inspected by the officers of the County Council or local authority.

In the interests of health and decency, it is hoped that these bye-laws will soon come into operation. There can be no reasonable doubt but that in some such way all our land-locked bays, in which our health resorts on the west coast are largely situated, will, sooner or later, require to be dealt with, since in many of

them the gross sewage is permitted to enter the sea, often not below low-water mark. Bathing, under such circumstances, and wading, therefore become impossible.

COUNTIES OF CLACKMANNAN, KINROSS, AND FIFE.

I.—CLACKMANNAN.

The principal stream in this county is the Devon, of which Burns, in August, 1786, sang—

"How pleasant the banks of the clear, winding Devon."

Nearly a century later (1870), Sir J. E. Alexander, of Westerton, sent the following statement concerning it to the Rivers Pollution Commissioners:—"One of the best breeding rivers in Scotland used to be the Devon, a branch of the Forth; the clear stream abounded in gravelly beds from its source downwards, and where, in the spawning season, the lusty salmon would be observed ploughing up the small stones and depositing their ova; but now, coming down the river to Tillicoultry, the character of the river is at once changed to a dirty ditch, loaded with all sorts of impurities from wool mills and dye works, and towards the mouth of the river dead fish are found on its banks—those which had imprudently attempted to ascend to the spawning ground."

Compare this with the report of the Medical Officer of Health for 1893:—"In order to show the progressive pollutions which go on in the stream from Dollar to Cambus, six samples of water were analysed, and the results show, as might have been expected, that above Dollar the water is comparatively pure, and might almost be used for all the primary purposes of a stream, but at Cambus the water has lost the semblance of water, and has become a dirty, foul-smelling, complex-chemical-compound of sewage, acids, alkalies, and dyes. The variety of chemicals which might be found in the stream will be better understood after the description of the trades carried on in Alva and Tillicoultry have been considered. The first sample of water, collected above Dollar, does not show that the pollutions which find their way into the stream higher up amount to very much, but any scheme for the purification of the Devon would be incomplete which did not take cognisance of all pollutions referred to in the Rivers Pollution (Prevention) Act."

The samples from the river, of which the following table shows the analyses, were taken on the same day at the following places,

namely:—(1) above bleachfield, Dollar; (2) below Dollar; (3) above Tillicoultry; (4) below that town; (5) below Alva; and (6) at Cambus.

Analyses of Water from Devon at points named.

One gallon contains in grains—

	1	2	3	4	5	6
Free Ammonia, ...	None	None	·0011	·0014	·700	·035
Albuminoid Ammonia,	·0025	·0070	·0049	·0012	·520	·392
Carbonate of Lime,...	6·30	3·85	4·20	4·55	7·70	7·45
Chlorine, ...	·70	·67	·66	·81	3·50	1·12
Nitrogen as Nitrates (Nitric Nitrogen),	·03	·007	Trace	None	None	None
Nitrates, ...	None	Trace	Trace	Trace	None	None
Hardness (degrees),	6·25	3·75	4·25	4·50	7·75	7·50

The principal pollutions which are poured into the river are:—

I. Sewage.—(1) Sewage from Dollar and neighbouring villas (partly treated by field irrigation); (2) slop-water from Devonside (1,600 persons); (3) sewage of Tillicoultry (crude); (4) sewage of Alva; (5) sewage of Menstrie; and (6) slop-water of Cambus.

II. Trade discharges.—

From (1) Bleachfield at Dollar.

(2) Wool spinning, - - ; Dyeing, - - - - ; Tweed making, - - — Tillicoultry.

(3) Wool spinning, - - ; „ scouring, - - ; Dyeing, - - - ; Tweed making, - - — Alva.

(4) Distillery and Breweries, Cambus.

(5) Coal-washings, - - Devon Coal-pit.

It requires no further description to show that the lower reaches of the river are in a deplorable condition.

II.—Fife and Kinross.

The three chief streams of Fifeshire are very badly polluted—namely, the Eden, Ore, and Leven; in addition to the Black Devon and Lyne Burn—minor streams,—which are in a like condition.

(1) The Leven, in its course from Lochleven to the sea, is very highly polluted with sewage, paper works refuse, bleach works discharges, refuse discharges from woollen and spinning mills, and distillery refuse. The state of this river during last summer was so bad that the Medical Officer of Health reported it to be a nuisance to the Kirkcaldy District Committee. For some years the condition of the Leven has been a matter of much concern to the Fifeshire County Council, which has been compelled to ask the permission of the Secretary for Scotland to proceed against the polluters, and consent has been given to take action under Part III. of the Rivers Pollution Act. The Council, together with the District Committee, are at present actively moving in the matter; intimation has been made to one of the chief polluters that action will be taken against them. That such firm action has exercised a salutary effect on some of the others is shown by the fact that recovery works have been constructed by one firm of paper-makers, although no action whatever seems to have been taken by those towns which throw their sewage into it.

(2) The Eden flows from the border of Kinross-shire, and falls into the sea at Guardbridge. It at one time was an excellent salmon river, but its glory in this respect has largely departed. Its chief pollutions are sewage from the towns of Cupar and Auchtermuchty, and from the village of Strathmiglo, not counting that of many smaller populous places and farmhouses on its banks; and alkaline and other discharges from paper works near its entrance to the sea. By reason of sewage contamination, it has long ceased to supply a water fit for primary purposes.

(3) The Ore, which has its origin partly in Lochfitty and partly in the Ochils, is also largely polluted by sewage, coal-washings, and bleachfield refuse discharges. Its water, like the others, cannot be used for primary purposes.

(4) The Black Devon pollution by sewage becomes a matter of serious import when it is remembered that it affords the water supplies of Alloa, Sauchie, and Clackmannan; while the Lyne Burn receives sewage from the town of Dunfermline, in addition to trade discharges.

COUNTY OF MID-LOTHIAN.

Some of the most remarkable evidence in respect of pollution which was submitted to the Royal Commission had reference to the rivers and streams of this county (*vide* Fourth Report, Vol.

I., pp. 19 *et seq.;* and Vol. II., Part IV., pp. 336 *et seq.*). The streams therein referred to are the North Esk, the South Esk, Water of Leith, the Foul Burn, the Braid Burn, the Niddrie Burn, and the Almond. In 1870 they were all extensively polluted with sewage, or with manufacturing refuse, or with both. In 1896 they are still polluted greatly. The Water of Leith has, however, within the last three years been considerably improved. The two Esks are still much polluted with paper-works refuse; the Braid Burn with Edinburgh sewage; and the Niddrie Burn with the refuse of the paraffin industry.

The Almond at this moment is probably one of the worst polluted streams in Scotland, and that chiefly from refuse discharges of trade processes. It deserves some detailed attention.

In the year 1865, Dr. Arthur Gamgee made a report on this river, in which he says that, from the evidence which he had collected, there was considerable pollution of the stream and its tributaries from the refuse discharges of paraffin works; to such an extent, indeed, that the water was rendered totally unfit for the chief purposes to which the water of a river is usually applied (Rivers Pollution Commissioners' Fourth Report, Vol. II., Part IV., pp. 320 *et seq.*). It had, in short, become unpalatable and repulsive to taste, and was poisonous to fish life.

This report was also considered to represent the condition of the stream in 1870.

In 1891 the County Medical Officer of Health made an inquiry into the condition of this river and its tributaries, and reported thereupon to the County Council. His report may be briefly summarised as follows:—The river rises near Shotts, in Lanarkshire, and from that point to where it reaches the sea it and its tributaries receive gross pollution from no fewer than forty-eight different sources. The pollutants consist of sewage from many villages, and from such populous places as Broxburn, East Calder, West Calder, Kirkliston, and others; coal-washings, near its source in Lanarkshire, from two different collieries; refuse of limestone mining from Camps Quarries; paraffin-oil works refuse from the West Lothian Oil Company, the legalised effluent from Addiewell, tarry matters and bing soakage from Breich Oil Works, crude discharges from the Deans Oil Works, from Hermand Oil Works, from Uphall Oil Works, the Holmes Oil Works, Pumpherston Oil Works, Oakbank Oil Works, and the Hopetoun or Niddrie Oil Works; ironstone pit

discharges from six ironstone pits, which impart to the river and bed of the stream a yellowish-red or ochrey appearance; and chemical soakage from old "blaes" bings. The condition of this river may, therefore, be better imagined than described. As the Medical Officer of Health puts it shortly:—"Fish cannot live in it; horses, cattle, and sheep drink sparingly of it, if at all; and for industrial purposes it is almost useless, on account of its destructive effects upon boilers." The Medical Officer also indicates, from experiments which he had made, that the bulk of the iron might be got rid of by the addition of freshly-slaked lime to the ferruginous water in settling tanks.

It will be observed that one of the most objectionable pollutions of the river is paraffin-works refuse discharges, and that the most of the polluting works permit these discharges to enter the river in a more or less crude condition. He points out, however, that this is neither necessary nor justifiable, since the effluent from the Addiewell Works, which is subject to a standard effluent by law, neither imparts a taste nor an odour to the stream into which it flows. This standard effluent was laid down by an Order of the Court of Session in 1878, and is as follows:—

"The discharge into the Breich Water and the Longhill Burn (tributaries of the Almond) shall, on analysis and calculation to the imperial gallon, not exceed the following proportions:—

	Discharge into Breich Water.	Discharge into Longhill Burn.
"Matter in solution, ...	25 grains.	100 grains.
"Matter in suspension, ...	10 ,,	25 ,,
"The discharge to be neutral, or, if acid, then the acidity is not to exceed when reckoned as sulphuric anhydride, ...	5 ,,	5 ,,
"Paraffin products as determined— (1) From discharge alone. (2) From the residue of (1) with soda. (3) From the residue of (2) with sulphuric acid by distillation of one ounce by measure in each trial, from twenty ounces by measure of original discharge.	Distillate added to fifty ounces of ordinary Edinburgh water shall not render the latter unpalatable or unfit for primary purposes."	

This standard the proprietors of the Addiewell Works conform to; and the Order just quoted shows, and the practical accomplishment of its terms at the works by a series of separators demonstrates,

how even a Court of Law may be able, from evidence, to establish a standard, and how paraffin discharges—among the most difficult to purify—may be sufficiently purified to prevent serious pollution and to injure its fitness for primary purposes.

In consequence of the very objectionable pollution of the Niddrie Burn by discharges from the Clippens Oil Works, a riparian proprietor applied to the Secretary for Scotland that a Government Inspector should be sent to examine that stream and the source of pollution; after which examination the inspector advised that the company should adopt measures whereby the sulphuric acid should be washed out of the effluent more completely, and thus permit it to pass into the burn in a neutral condition. These works are, we believe, now in process of construction.

It may be added that the Niddrie Burn, which, on the statement in 1870 of the Sanitary Inspector of Uphall Parish, was "quite free of any nuisance whatever," is, in 1896, much polluted.

County of Linlithgow.

The principal streams of this county are tributaries of the Almond, and the Avon and its tributaries—namely, the Logie Water and the Conston Burn.

Having already dealt with the condition of the Almond, we will now consider the condition of the Avon.

In 1864, Dr. Stevenson Macadam, of Edinburgh, and Dr. Machattie, of Glasgow, both chemists, made an examination of this river of a very exhaustive character, which was laid before the Rivers Pollution Commissioners, and which is printed in Vol. II. of their Fourth Report, pp. 327 *et seq.* Although the river was in flood when the samples were taken, upon which their analyses were made and their opinions were based, they found that the streams were impregnated with paraffin-oil products to such a degree that fish could not live in the water—indeed, in the whole course of the river examined by them they did not observe a single fish—and with chemical discharges from the Avon Print Works, and they concluded their very masterly report by saying:— "We are decidedly of opinion that in dry or summer weather, when the burns or streams are small, that the effects of the discharges from the chemical works must be highly pernicious and offensive, that the death of the fish in the Avon may be fairly attributed to the diffusion of paraffin products in the water, and

that the paraffin vapour rising from the water militates against the neighbourhood of the Avon river as a residence."

In 1870 statements by several witnesses indicated the seriously polluted condition of the stream at that time. (Fourth Report, pp. 318 *et seq.*) One witness declared, indeed, that the people cannot use it at all, even for washing clothes, far less for cooking, and are constrained to go to a distance for clean water for culinary purposes; formerly, "the Avon supplied all their wants."

In 1896 the river was mainly polluted with coal-washings and paper-mill refuse discharges.

COUNTY OF STIRLING.

The principal streams of this county are the Forth, Carron, the Bonny, the Avon, and the Blane.

The Forth, in its course to below Stirling, receives the sewage of the following populous places—namely, Aberfoyle, Buchlyvie, Kippen, Gargunnock, Cambusbarron, Bannockburn, Causewayhead, and Cambuskenneth, and of Stirling itself. But it has to be borne in mind that only three places of this series—namely, Causewayhead, Cambuskenneth, and Stirling—drain directly into the river, while the sewage of the others only reaches the river by minor streams, which have varyingly long courses before they reach the Forth. There are no public works meanwhile on the river banks between its source and Stirling. The Teith, which joins the Forth at a point a little above Stirling, is also polluted to some extent, but this is a Perthshire river for a considerable portion of its course. The Allan is likewise polluted with sewage from Dunblane and Bridge of Allan, and from bleach work refuse. Evidence was adduced before the Commission in 1870 by a number of farmers that the Bannock—a tributary stream of the Forth—was so seriously polluted that cattle and horses would not drink of it, and that it was not uncommon to see dead trout and salmon lying in the stream near its junction with the main river. Till it reaches Stirling, the Forth is by no means so grossly polluted as some of the other rivers of Scotland, but below this town the beds of black mud and slimy ooze apparent on the banks amply testify to the gross pollution which it receives from that populous place.

It is satisfactory to learn from the reports of the Medical Officer of Health for the County that a preliminary movement is

being made to prevent the introduction of sewage from the places above named into the river.

The river Carron has been for many years a most unsightly blot in the landscape, being largely polluted by the refuse discharges of paper works and of naphtha works, and by the sewage of the town of Denny. Vigorous efforts are at present in progress to restore the stream to a state of comparative purity, and already some measure of success has attended these efforts, although not yet apparent in the appearance of the stream. Certain paper works have instituted works for the recovery of their waste caustic soda, and the value of the products recovered is more than sufficient to cover the annual cost of the works. This is another evidence of a destructive discharge being capable of effective treatment. There remains still much to do, however, before the river is purified.

The Bonny was also much polluted by alkaline discharges from paper works and the refuse discharge from a distillery. The action of the Stirling County Council, and the co-operation of the owners of these works, have now resulted in improvement.

The Avon, being the boundary between the county and Linlithgow, comes partly under the purview of this county. As has already been noted, it is much polluted by coal-washings and paper-work discharges.

This river—the Blane—was at one time largely polluted by discharges from the Blanefield Print Works, but these, however, are removed from the river to the extent that the settling ponds enable a clear effluent to be sent into the stream. The system of purification here adopted is that of Mather & Platt, which is a scheme of precipitation by chemical reagents, the effluent being drawn off clear from the surface of the tanks by means of floating arms, while the precipitated sludge is forced into an adjoining pond by steam pressure. The whole process of purification *per tank* is about two hours. The remaining pollutants are sewage from two villages, and refuse discharges from a distillery. Steps are at present being taken to prevent the entrance of the former in a crude condition.

County of Roxburgh.

The rivers of this county are the Teviot, the Jed, and the Tweed.

In 1870 evidence given before the Commission clearly showed the very polluted condition of all those streams.

The Teviot receives the sewage of Hawick and Jedburgh, and also liquid refuse from woollen manufactories, dye-works, and tanyards, in addition to cinders and spent bark.

In 1894 the Medical Officer of Health reported that the river for miles below Hawick was very foul for several months during the dry weather of 1893. Hawick in 1870 discharged its crude sewage straight into the river; now, however, it makes an attempt —said to be inadequate—toward its purification.

The Jed in 1870 was in a very filthy condition. "The bed of the river is polluted by town sewage and liquid refuse from woollen manufactories, dye-works, tanyards, skinneries, slaughter-houses, gas-works, and sheep-dip manufactories."

In 1894 this river was as foul as the Teviot, and "as much like a sewer as possible."

The Tweed, when it reaches the junction with the Teviot, is very seriously polluted. In 1870 the Commissioners were satisfied of this, not only from the evidence led, but also from analyses of samples of water of the river taken at different points. It is open to doubt whether any improvement has taken place up till the present time; certainly, there has been no substantial change in this direction. In 1894 it showed unmistakable physical signs of pollution. That can hardly be wondered at when it is remembered that up to this point it has received the sewage of Galashiels, Innerleithen, Walkerburn, Hawick, and Jedburgh, together with the discharges from a large number of mills, dye-works, slaughter-houses, &c. The importance of this pollution becomes apparent when it is remembered that Kelso—4,000 inhabitants—takes a large quantity of its water supply from the river, and it "is barely ever free of enteric fever." (Report of Medical Officer of Health, 1894.)

In the annual report of the Medical Officer of Health (1895) it is stated that, complaints having been made to and by the Hawick and Melrose District Committee, Mr. Curphey, Inspector for Scotland under the Pollution Act, 1876, was instructed by the Secretary for Scotland to make an inquiry and to report. His report is now in the hands of the County Council for consideration.

COUNTY OF DUMFRIES.

The principal streams of this county are the Nith and its tributaries—namely, the Scaur and the Cairn; the Annan, and the Esk.

The Nith flows from the north-west of the county, and passes right through it to the Solway. For the most part it taps agricultural land or moorland. It receives the sewage of New Cumnock, Kirkconnel, Sanquhar (partly treated), Thornhill, Maxwelltown, and Dumfries. Of trade discharges it receives, near New Cumnock, the coal-washings of pits in that neighbourhood, the alkaline, soapy, and sulphurous discharges from woollen mills near Sanquhar, and more coal-washings from the same neighbourhood. Until recent years the unsightly appearances which such coal-washings produce on a stream were unknown on this river, probably by reason of the fact that coal-washing is of very modern origin. In the summer of 1894 we were suddenly brought face to face with this pollution while occupying summer quarters on its banks, and while engaged in angling. For the best part of August of that year the water of the river, usually clear, ran quite black, so that it was impossible, without risk to life, to wade while angling. It was equally impossible to see a bright silver coin in three inches of water. The natural sand banks were covered with fine coaly particles and small chunks of coal. Complaint was made by the Angling Association, and it was reported, after inquiry by the County Council, that the pollution was only temporary, having been produced by the bursting of a settling pond.

In 1896, however, from October till Christmas, the same continuous pollution recurred, as it had done, on occasion, between these dates. On this latter occasion the Medical Officer had to report that the effluent from the pit in the county "is not so satisfactory as might be wished—the amount of solid matter being such as to pretty completely blacken the water and discolour the left bank of the river for some way below its entrance."

In the month of December the river, near New Cumnock, was running quite black from the pollution from Ayrshire pits. The County Council have called upon the lessee of the former "to take early steps towards effectually abating the cause of the complaint," and to seek joint action with the Ayrshire County Council in the prevention of the latter.

The mischief may be somewhat gauged by its effects on fish. In 1894 we picked out of the river, at points respectively distant 2½ and 5 miles from the source of the pollution—and that without any strict search—three salmon, one of about 18 lbs. weight. Post-mortem examination showed in each case that suffocation was the cause of death, as in each case the gills were clogged with

fine coaly particles, and in the stomach of one of the fish a small chunk of coal, about the size of a filbert nut, was found. Within the last few days, an angler, who has resided on the banks of the river for over 50 years, and who has fished it regularly for the last 30, writes me that he has to record, for the first time during that period, a blank, and further that, whereas in former years, spawning fish were abundant at this season, he has not been able to see any during the present season. These facts need not be enlarged upon to show the disastrous effects on fish life and upon the amenity of the river.

The Scaur is polluted with the overflow of the sewage of Penpont; and the Cairn, by the sewage of small populous places.

The Annan is polluted by the sewage of Moffat, of which complaints have been made, in consequence of which the District Committee of the County Council have had to threaten the Commissioners of that town with legal proceedings. In addition, this river also receives the effluent from Lockerbie sewage. The burgh of Annan discharges its sewage and brewery refuse into it, below tidal waters, however.

The Esk is polluted by the sewage of Langholm, and by refuse discharges from mills, a dye-works, and a tannery. Complaint has been made of the offensiveness of the river when low, and it is more than likely that an action of interdict will soon be raised by the principal riparian proprietor of that neighbourhood.

COUNTY OF LANARK.

Probably by reason of this county being the centre of very varied and numerous industries, the streams have long had a notoriety in respect of their polluted condition. Its principal stream is the Clyde, with its numerous tributaries—namely, the Daer, Elvan, Glengonar, Duneaton, Garfe, Culter, Roberton Burn, the Medwyn, the Douglas Water, the Mouss, the Nethan, the Avon, the Cadzow Burn, the South Calder, the North Calder, the Rotten Calder, and the Kelvin.

The first tributary to be polluted—beginning from the source—is the Glengonar, which receives the refuse from lead-ore crushing at Wanlockhead. The Duneaton carries into it the sewage of Crawfordjohn; and some of the others, the sewage or slop-water of other small populous places, as Elvanfoot, Abington, Roberton, Wiston, Lamington, Culter, and Thankerton.

The Medwyn, which joins the Clyde above Carstairs, brings down paraffin refuse from the Tarbrax Oil Works. At a point a little above the junction Carstairs derives its water supply. Between this point and Lanark it receives the sewage of some small hamlets, and is joined by the Douglas Water, which, with its tributary burns, is badly polluted with coal-washings from the pits at Coalburn and Bankend in Lesmahagow Parish, and with the sewage of Douglas and these mentioned places. In June and September of last year I found a tributary of the Douglas Water running as black as ink, with silted coal dust along its banks. Lanark pours its sewage into it after rough irrigation, as do also the adjacent villages of New Lanark and Kirkfieldbank. Near Lanark it is joined by the Mouss, which brings also its quotum of sewage, &c., from villages on its banks. Five miles lower down the Nethan brings pollutions of coal-washing and sewage. Between this point and Hamilton it receives the sewage effluents of Carluke, Law, Wishaw, &c., on its right bank, and of Larkhall and some villages on its left bank. Hamilton empties its crude sewage into it. A little above the town it is joined by the Avon, and below it by the South Calder, which, likewise, brings coal-washings, sewage, and manufacturing refuse. It receives also the refuse waste of Blantyre Mills and the sewage of Uddingston, and below this place it is joined by the North Calder, which is a fearfully polluted stream, owing to sewage, coal-washings, and other trade refuse, and, last of all, by the Rotten Calder, which now fits its name. It then receives the sewage of Rutherglen and the bulk of that of Glasgow, together with all the multifarious kinds of trade refuse from that city. The Kelvin, Cart, Leven, and some minor streams, swell the noisomeness and abomination on its course to the firth.

In short, the Clyde, about 90 miles in length from its source to the sea, drains about half-a-million of acres of land, and before it arrives at Glasgow receives the daily sewage of about 350,000 people, the coal-washings of about 30 collieries, the refuse of paper mills, gas-works, mills—paper and others—calico-printing works, dye-works, and of about half-a-dozen of sulphate of ammonia works. It is little wonder then that, even before it reaches this city, its waters become gradually more filthy as we approach the city, and the filthiness attains its maximum before it reaches Bowling.

Another main tributary of the Clyde, but proceeding from the county of Renfrew, is the Cart, which, at the point where it joins

the Clyde, is composed of the waters of the White and Black Carts. The White Cart rises in the south-east corner of Renfrewshire, and in its north-westerly course receives the sewage of Busby, Thornliebank, Cathcart, of Battlefield and Langside in the city of Glasgow, Pollokshaws, and Paisley and its suburbs, in addition to the trade refuse of bleach works, calico-printing works, paper works, laundries, cotton-thread works, woollen factories, dye works, and starch works. The Black Cart runs out of Kilbirnie Loch, and is, generally speaking, less foul than the White Cart, although in summer, when the water is low, it becomes very foul. Its pollutions are akin to those of the other river. They unite a few hundred yards above the junction of the river with the Clyde.

COUNTY OF FORFAR.

The principal streams in this county are the North Esk, the South Esk, the Dighty, the Brothock, and the Isla and its tributary, the Alyth Burn. The first two are still in a condition of comparative purity, but the Dighty and Brothock have an unenviable notoriety for pollution.

In 1870 the seriously polluted nature of the Dighty received much attention from several parties who appeared before the Commission. (Fourth Report, Vol. II., Part IV., pp. 308 *et seq.*) Nine of the bleaching firms on this stream acknowledged this impurity, and agreed that certain means for purification—which they named—should be carried out. One witness stated the water was unfit for the use of man or beast, and "is now quite thick and covered with a white froth."

In 1896 this stream is still polluted to a serious extent.

Of this stream it is reported in 1892 that "the water has a disagreeable appearance, and often a very offensive odour, . . . but, in all probability *is not worse*, than described in the Report of the Commissioners." (*Vide* above.)

The Brothock is also seriously polluted. The Isla is principally polluted by its tributary, the Alyth Burn, which brings into it the effluent of the sewage of Alyth after undergoing rough irrigation, and the refuse liquids of a woollen manufactory, which latter impart a milky colour to the stream.

Probably enough has now been said to indicate to what extent pollution exists in our Scottish rivers at the present day. But it may be noted, as corroborating a remark made at the outset, that

in such counties as Sutherland, Caithness, Ross and Cromarty, and Argyll, it does not exist; and that in such counties as Perth, Galloway, Banff, Elgin, Nairn, and Haddington, although pollution does exist in their principal rivers to a varying extent, it never reaches the acute stage which it does in those counties whose rivers we have dealt with in greater detail.

From the foregoing, then, it will be easily apparent that the extent and incidence of river pollution is substantially the same to-day as it was twenty-five years ago, when the Commissioners made their inquiries into the condition of rivers. There may be here and there a slight alteration for the better, but, on the other hand, there are several streams which, then pure, have become sadly polluted, and some, also, which have become more polluted since that time. Probably one of the most recent of the many pollutions is that of coal-washing, as it is one of the most recent developments in connection with the utilisation of coal. But the other pollutants, such as sewage and the many kinds of trade discharges, remain practically the same, and the results on our rivers to-day are identical with those of a quarter of a century ago. Many sanguine people believed, after the exhaustive Reports of the Commissioners, which embodied the vastness of the extent to which pollution existed, and after the Act of 1876, which was passed by the Houses of Parliament as the result of the work of that Commission, that improvement would quickly be apparent in the returning purity of our streams. But this hope was quickly dispelled, owing to the perfect inaction of the local authorities of the Public Health (Scotland) Act, 1867. It was, however, once more raised by the passing of the Local Government Act of 1889, and the institution of new public bodies, which were endowed with larger powers. Probably the time is too short since their appointment to expect much improvement, but the unfortunate fact remains that, notwithstanding the energetic action of some of these County Councils, little or no improvement has been attained. It will be interesting now to inquire into the reasons why.

In the first place, the Act of 1876 is permissive—that is to say, while the Act (Section 8) says that "every sanitary authority shall have power to enforce the provisions of the Act," they are not compelled to set the law in motion. It has always been found as a consequence of permissive legislative enactments that bodies in whom the power of action is vested are slow to take advantage

of them; so has it been in respect of this Act. Various reasons may be given for this. First in order, there is a fear that trade prosperity might be unduly hindered, that capital would be estranged from localities wherein such restrictions were enforced, and that the very narrow margin of profit which often attends the successful carrying on of works would be swept away, works would be stopped, and there would follow serious loss to work-people thrown out of employment, with all the attendant misery. These prophetic utterances are generally put forward as a cloak to inaction by those who ought to enforce the powers of the Act, and they have been fostered by manufacturers, who naturally do not desire to expend more capital than they can avoid, and who possibly also believe that the preventive measures which they shall be asked to adopt will prove costly. Doubtless there is something in this which demands very careful consideration on the part of those who have to administer this Act. But what does experience show? It has been amply demonstrated that, in respect of each and all of the polluting matters mentioned in the Act, efficient means of prevention have by no means been costly, and, further, that the very demand for such preventive measures has not unfrequently resulted in the discovery of some method whereby what formerly was thrown into the stream as a waste product could be recovered and utilised as a by-product, and thus help to minimise the expenditure for such works.

Another reason for this inaction is to be found in the fact that those who ought to administer the law are themselves, not unfrequently, the worst offenders. That this is so there is good reason to believe, and it is not in human nature to think that anyone is likely to set the law in operation against himself. And while the old saying that "example is better than precept" is trite and true, it would appear that in but few instances in a matter like this is it carried out. In addition to this, and probably as part of the same general fact, the administration of the law is deputed by the County Councils to the District Committees, which are composed of those who ought to be most interested in the purification of the rivers in their respective localities, but who often, perchance, are themselves contributors to this pollution, or, if not contributors, are likely to be on terms of intimacy or interested with those who are. Here again it is not in consonance with human nature to expect that much will be done. Indeed, as one Health Officer puts it in one of his reports,

"At present the County Councils are inclined to shunt the responsibility of the Act on the District Committees, while the latter, in most instances, allow the Act to lie on the table."

But there are some County Councils which are striving to do their duty in respect of river purification. Beginning at first with the obviously best method of carrying manufacturers and other polluters with them in the project of restoring streams to the condition in which they found them, or as near as may be, they have not unfrequently succeeded in isolated cases among public-spirited owners in obtaining their hearty co-operation. But sooner or later they find that the bulk of polluters will not move unless at the point of the legal bayonet. And now they are confronted with fresh difficulties, which mainly consist of (1) difficulties with the ratepayers, and (2) difficulties in the Act itself.

Of the former it may be said that while popular representation has many wholesome features, it is also not unattended with drawbacks. The representative who honestly tries to do his duty, and who, perchance, in so doing causes expenditure of the public rates to appreciable, although trifling, increased taxation, often becomes the object of obloquy by the public, who do not fully understand the questions at issue, and when he presents himself for re-election is inevitably confronted by a candidate who is all for economy, retrenchment, and reform. Unquestionably this ought to have some wholesome terror for the reckless representative, while it should have none for the careful. But, nevertheless, experience closely illustrates that this is a difficulty. It only ceases to be one when the ratepayers become educated on the subject, which, we fear, has not yet been attained generally in reference to public health matters. Suppose, however, that a sanitary authority, be it County Council, District Committee, or Local Authority, deem it necessary to set the law in operation, what difficulties present themselves in the Act itself? It may be said, in a word, that the whole Act bristles with difficulties, which have been due, doubtless, to a desire—a very proper desire too—that manufacturing interests should not be constantly or needlessly harassed by the operations of the Act. County Health authorities view this Act from different standpoints, of which the following may be taken as typical—namely, (1) that interference is not demanded where the river impurity cannot be proved to be injurious to the public health; and (2) that so long as an impure stream does not form the source of a potable water supply

interference is not required. These are views which should not at all emerge from a careful reading of the Act. *It is not a Health Act;* indeed, there is not a phrase, not even a single word, in it which indicates that the Act was passed with reference to the public health. The above construction seems to have been read into it by reason of the fact that those who were to administer it were those who also had to administer the Public Health Acts.

The preamble shows this very clearly :—"Whereas it is expedient to make further provision for the prevention of the pollution of rivers, and, in particular, to prevent the establishment of new sources of pollution. Be it enacted," &c. This is further shown by the phrasing used in certain sections of the Act. For example, in Sections 2, 5, it is clearly stated that it is an offence if the polluting substance put into the river shall "interfere with its due flow, or pollute its waters" (Section 2); or, as in Section 5, shall "prejudicially interfere with its due flow," &c. Here one of the principal objects of the Act is to prevent interference with the flow of water, apart from any consideration of public health. It is, however, just possible that the words occurring in Section 4, "poisonous, noxious, or polluting liquid," predicate the effect on living objects—animal and human—of a poisonous or noxious character. That is quite likely. But, obviously, the effect may be construed to be either upon animals that naturally live in and who receive their means of life from water—as fish—or upon animals, including man, which may receive part of their life sustenance in the form of water from a stream in such a condition. Here, by inference, there is injury to health. But this cannot be urged so much of mere solid matters, as of sewage, or of chemical refuse. The offence which is mainly perpetrated by a contravention of this Act seems to be one which militates against the use of the water for primary purposes—for drinking, and for use in such trade processes as require the use of clean water. However that may be, let us now notice still further the difficulties which present themselves in the Act itself.

It is not an uncommon phrase in several sections of the Act—namely, "the restrictions in this Act contained." What are these restrictions? In the first place, let us suppose that a sanitary authority is compelled to enforce its enactments in respect of the passing of any poisonous, noxious, or polluting liquid into a river, stream, canal, lake, or water-course, a written notice of the

intention to take such proceedings must be sent to the offender, and after the lapse of two months after such notice proceedings cannot even then be taken without the consent of the Local Government Board, which for Scotland is construed to mean the Secretary for Scotland (Section 21, Sub-section 4), which consent, too, is likely to be contingent upon an examination by an inspector, armed with all the necessary powers, and appointed by the said Secretary, who, in his report, "shall have regard to the industrial interests involved in the case, and to the circumstances and requirements of the locality," and in respect whether the "means for rendering harmless the poisonous, noxious, or polluting liquids proceeding from the processes of such manufactures are reasonably practical and available under all the circumstances of the case, and that no material injury will be inflicted by such proceedings on the interests of such industry." Suppose that the report of this inspector is such as warrants the Secretary of State to grant consent, the field is not even yet clear for the contemplated action to be taken. For, notwithstanding this consent, the offender is at liberty to object before the sanitary authority to such proceedings being taken, and, if required in writing by him, the sanitary authority is bound "to afford him an opportunity of being heard against such proceedings being taken, so far as the same relate to his works or manufacturing processes." The offender thereupon must be allowed to be heard by himself, agents, and witnesses. Then, after this inquiry, due consideration having been given to the same points upon which the Secretary for Scotland based his consent, the sanitary authority is bound to determine whether the action shall cease at this point or shall proceed. Thereupon, in the latter event, a case is laid in the Sheriff Court against the offender for decision, from which, however, either party may appeal to the Court of Session in either division of the Inner House; or alternatively with leave of any judge of the Court of Session, if to him it appears desirable in the interests of justice that the venue should be changed, the case may be removed from the Sheriff Court to the Court of Session, and there tried in the first instance.

It is very necessary in the interests of manufacturers that every care should be taken that no unnecessary hardships should be inflicted upon trade interests, but, probably, no more elaborate scheme could have been devised than the foregoing to attain this end. But, besides involving not only a considerable waste of time,

it not infrequently also, when the trade interests are powerful, involves an extravagant waste of money.

We do not propose, however, at this stage to discuss whether or not it is the best way of dealing with the subject. That will come later.

Another reason which has doubtless operated to give pause to action by County Councils is the absence from the Act of any standard of impurity—that is to say, of any fixed tests of a quantitative kind by which, if any water did not conform to them, it could be declared polluted. It is difficult to understand why such standards were not incorporated in the Act of 1876, for there is nothing clearer than that it was the intention of the Commissioners that such a standard of impurity should be laid down, in order that any action might have a base from which to begin. That it is possible to lay down such standards is obvious from the results of the many analyses of various streams, polluted and unpolluted, which were made by one of the Commissioners on the spot. It has been urged by some that it is impossible to lay down any such standards which would be of common application to all rivers. This of itself would form a subject of very profitable study, but time would not now permit of its full discussion. That it would not be difficult is apparent from the standards of the Commissioners—some of whom were scientific men,—and that it is not impossible for a Court of Law, guided by expert evidence, is clear from the decision of the judge in the case of the Addiewell Oil Works. But the want of such a standard in the Act, coupled with the restrictions of the Act itself, the indefiniteness of many of its terms, and the protracted and often costly character of the legal process for remedy, have separately or collectively contributed much to hinder the setting of the law in motion.

After four years of constant investigation into the condition of the rivers of Great Britain, the Commissioners proposed the following as the standards of purity to which any effluent from any process, manufacturing or otherwise, should comply before being permitted to enter a stream—namely:—

(1) Any liquid containing, *in suspension*, more than *three* parts by weight of dry mineral matter, or one part by weight of dry organic matter, in 100,000 parts by weight of the liquid (that is, 2·1 grains per gallon of dry mineral matter, and ·7 grain of dry organic matter per gallon).

(2) Any liquid containing, *in solution*, more than *two* parts by weight of organic carbon, or ·3 part by weight of organic nitrogen in 100,000

parts by weight (that is, 1·4 grains of organic carbon, and ·021 grains of organic nitrogen per gallon).

(3) Any liquid which shall exhibit by daylight a distinct colour when a stratum of it, one inch deep, is placed in a white porcelain or earthenware vessel.

(4) Any liquid which contains, *in solution*, in 100,000 parts by weight, more than two parts by weight of any metal, except calcium, magnesium, potassium, and sodium (that is, 1·4 grains per gallon).

(5) Any liquid which, in 100,000 parts by weight, contains, *whether in solution or suspension*, in chemical combination or otherwise, more than ·05 part by weight of metallic arsenic (that is, ·035 grain per gallon).

(6) Any liquid which, after acidification with sulphuric acid, contains, in 100,000 parts by weight, more than *one* part by weight of free chlorine (that is, ·7 grain per gallon).

(7) Any liquid which contains, in 100,000 parts by weight, more than one part by weight of sulphur, in the condition either of sulphuretted hydrogen or of a soluble sulphide.

(8) Any liquid possessing an acidity greater than that which is produced by adding two parts by weight of real hydrochloric acid to 1,000 parts by weight of distilled water (that is, 140 grains of hydrochloric acid per gallon).

(9) Any liquid possessing an alkalinity greater than that produced by adding one part by weight of dry caustic soda to 1,000 parts by weight of distilled water (that is, 70 grains of caustic soda per gallon).

(10) Any liquid exhibiting a film of petroleum or hydrocarbon oil upon its surface, or containing, in suspension, in 100,000 parts, more than ·05 part of such oil.

The first three tests have reference to sewage, and discharges from calico, woollen, linen, jute, silk, and paper works, skinneries, and tanneries, and the remainder almost solely to chemical works.

Some of them have special reference to fish life; some to nuisances against the eye; and others, especially numbers 7 and 10, to possible injury to health or public discomfort.

These proposed standards of purity were submitted for opinion as to their suitableness to Liebig of Germany, Dumas of France, and several eminent English chemists, who expressed their entire concurrence with them. The standard of purity which Dumas mentions in his communication as the one upon which he would mainly rely for any river is worth quoting. He says, "Whenever water was so affected by a town or manufacture as to become unfit for supporting the life of fish or of green plants, the pollution, from whatever cause derived, should be considered as an insupportable nuisance to the riparian population."

Another lack in the Act is the absence of penalties for offences committed. It would appear as if the only penalty to be inflicted on offenders was their duty of ceasing the offence, or for disobedience

in not carrying out any orders of a Court of Law. There is, therefore, nothing, on the face of the Act, to act as a deterrent to offenders.

Enough has probably been said to show reasons why County Councils are loth to assume aggressive action in respect of the pollution of rivers.

When, again, it is proposed by a County Council, or other local authority, to prevent pollution of tidal bays or lochs, such as may be under the care of counties which have a seaboard with towns in such situations, whether the pollution be due to sewage or the other impurities mentioned in the Act, and provided that such pollution has not been permitted by special Act of Parliament obtained in the interests of a populous place, it is first of all necessary that such tidal bay or loch should be declared, for the purposes of the Act, to be "a stream." The Secretary for Scotland must then be asked to declare said bay or loch to be a stream, which he may do after local inquiry, and on sanitary grounds; and the Order which declares it to be "a stream" must be published in the *Edinburgh Gazette.* The Council may thereupon, in virtue of Section 57 of the Local Government (Scotland) Act, 1889, make bye-laws for the prevention and suppression of nuisances not already punishable in a summary manner by virtue of any Act in force throughout the county, provided that they have been duly approved by the Secretary for Scotland. And it is believed that such bye-laws can be made to prevent pollution of a tidal bay or loch. In fact, the County Council of Dunbarton have proceeded in this way in respect of the pollution of the Gareloch—a procedure which may be recommended to other seaboard Councils with like water areas under their supervision.

With reference to river pollution which can be proved to be offensive or injurious to the health of those living in the vicinity of such river, sanitary authorities find authority for action against polluters in certain sections of the Public Health (Scotland) Act, 1867. Section 83 provides that "owners or occupiers of distilleries, manufactories, and other works, shall be compelled, *where possible,* to dig, make, and construct pools or reservoirs within their own ground, or as near their works as possible, for receiving and depositing the refuse of such works, so far as offensive or injurious to the health of those living in the vicinity thereof, or to use the best practical means for rendering the same inoffensive or

innoxious before discharging it into any river, stream, ditch, sewer, or other channel;" and Section 27 has a direct bearing on the pollution of potable water supplies. It reads as follows:—"Any person engaged in the manufacture of gas, naphtha, vitriol, paraffin, or dye-stuffs, or any other deleterious substance, or in any trade in which the refuse produced in any such manufacture is used, who shall at any time cause or suffer to be brought or to flow into any stream, reservoir, aqueduct, well, or pond, or place for water, constructed or used for the supply of water for domestic purposes, or into any pipe or drain communicating therewith, any product, washing, or other substance produced in any such manufacture, or shall wilfully do any act connected with any such manufacture whereby the water in any such stream, reservoir, aqueduct, &c., shall be fouled, and any person who shall wilfully do, or permit to be done, any act whereby the water in any stream, reservoir, aqueduct, &c., for the supply of water for domestic purposes shall be fouled, shall forfeit for every such offence a sum not exceeding fifty pounds." Section 83—the former which I have quoted—has a distinct reference to offence to comfort and to injury to health. These sections do not necessarily form a complement the one to the other, and it is equally a contravention of this section whether the pollution causes the stream to be offensive in any way to those living near, or whether it goes further, and produces actual injury to health.

In the Annual Report of the Board of Supervision for 1869, p. 19, in connection with a complaint of pollution of the River Leven, Fifeshire—a complaint which has continued up till now—the Board states that it was advised by counsel that "offensiveness" was to be construed as distinct from "injury to health," and that to prove the former it was not necessary to prove the latter.

Section 27, although it must be read along with other sections of the Act, constitutes the mere "fouling" of a stream, &c., the water of which is used for domestic purposes, to be an offence. In accordance with this section, in the case of the Barony Board and the Police Commissioners of Kirkintilloch, it was ruled that the Commissioners were not entitled to discharge the sewage and polluted drainage into the adjacent river so as to cause the water to be unfit for domestic or other primary purposes. By this decision the Commissioners were compelled to treat the sewage of the burgh, which they did, and are now doing, in conjunction

with Lenzie, by intermittent downward filtration. The "fouling" of a stream, therefore, does not require for conviction proof of mischief to the public health *in esse*, if it can be shown to be *in posse*.

Besides, in the Gas Works Clauses Act, 1847 (10 and 11 Vic., cap. 15), which applies to Scotland, Section 21 imposes a penalty of £200, and £20 *per diem* during which the nuisance exists, upon any gas company which fouls a stream with gas-washings after twenty-four hours' notice has been given.

The Salmon Fisheries (Scotland) Act, 1862, Section 13, made provision for the prosecution of manufacturers who polluted salmon rivers to the injury of fishing and fish life, and several successful prosecutions were carried through against manufacturers who polluted the River Forth; but in the amended Act of 1868 the wording of this section was so changed that it became useless for this purpose.

What has been said up till this point embraces the various Acts of Parliament which contain provisions for the prevention of the pollution of streams. It is comparatively rare to find, doubtless owing to the lukewarm methods which generally characterised local authorities in respect of the administration of public health enactments in every department up till the passing of the Local Government Act, 1889, any well-defined or systematic attempt made to cope with advancing pollution, which, in the memory of all, has, in certain forms, been increasing by leaps and bounds. It is yet too soon, moreover, to look for much result at the hands of County Councils, however much energy they may have been, or may be, displaying in this direction. But on all hands there is a general complaint that, in reference to *public action*, the enactments at present in force are so hedged round with restrictions—in short, which are so clumsy—that but little benefit must be looked for from action based upon it in the future.

Public action, or rather action in the interests of the public, is, however, no bar to private action against the river polluter. If one were to form a conclusion from the past respecting the prospects of success in an action for river pollution as between a public body, acting upon special Acts of Parliament, and a private individual who lays his action at Common Law, that conclusion would be that success is more likely to attend the latter than the former. At the same time, it must not be forgotten that the Rivers Pollution Act makes provision for an action being initiated, in terms of that Act, by "any person aggrieved by the commission

of such offence." (Section 8.) The only advantage in adopting this mode is that the expenses of the action will fall to be paid by the ratepayers, whereas the disadvantages are those which have been already dealt with as constituent of the Act.

Common Law, however, would seem to provide a more rapid solution of a complaint than this special Act of Parliament, and it would appear, if some amendment of the present law be not effected, that more success is likely to follow the action of any person who can show a substantial grievance than if it be raised at the public instance. The celebrated Esk case and many others demonstrate this. In the former case the following statements by the then Lord-Justice General are memorable:—He said, "There could be no doubt that water had been sent for the use of man, and although he was to use it he was not to abuse it, and he considered it only right that man when using water should again return it to the river in as pure and wholesome a state as when he took it, so that his brother and neighbour below him might enjoy the same benefits by getting the water sent him in as pure a state as he got it." This is plain common sense, and, we may take it, the soundest law coming from such an authority.

Indeed, so acute has the difficulty become in overcoming river pollution by local authorities, that those who are actively engaged in the administration thereof are not slow to urge that success is to be more likely found here than at the public instance. This forces us then to the conclusion that, if river pollution is to be remediable, there is something lacking in the Act of 1876 which would enable a County Council to look after the public interests, or, in other words, that the Act requires speedy amendment.

This is by no means a new view. But it is probably much easier to urge amendment than to frame the amendments themselves. The attempt, however, must now be made.

In the first place, let us inquire whether or not any practical steps have been taken to render action against river pollution less costly and less clumsy since the Act of 1876 was passed. As this nuisance exists to a very alarming extent in some of the English counties, and as certain Councils in their attempts to enforce the Act of 1876 found it to be practically unworkable, they were compelled to go to Parliament for special legislation to overcome their difficulties.

In 1892 the Lancashire County Council obtained an Act intituled "The Mersey and Irwell Joint-Committee Act, 1892,"

and in 1894 the Council of the West Riding of Yorkshire obtained the "West Riding of Yorkshire Rivers Act, 1894."

Let us consider briefly the latter Act as being nearer the present time, and as showing the likelihood of Parliament amending the Rivers Pollution Act of 1876. In all essentials they are substantially identical. The very preamble of the Yorkshire Act is a condemnation of the General Act of 1876. It begins, "Whereas the restrictions contained in the Rivers Pollution (Prevention) Act of 1876 are such as to preclude effective action by the joint-committee for the improvement of the conditions of the said rivers or parts thereof, and the tributaries; . . . " and whereas the polluted and filthy condition of the said rivers, &c., urgently requires improvement, it is desirable and expedient to confer such powers, &c., as are asked.

It may be stated generally, at the outset, that the provisions of this Act—due to the indeterminate character of some of those of the General Act of 1876—are calculated to define with greater precision (1) the places that are probably liable to pollution; and (2) what is liquid sewage, while the definitions of "solid matter" and "polluting liquid" receive the same interpretations as in the General Act.

In the second place, there is a larger inclusion of the kinds of pollutants which may enter a stream, and instead of a general definition of solid matters, as in the Act of 1876, as "the solid refuse of any manufactory, manufacturing process, or quarry, or any rubbish or cinders, or any other waste, or any putrid solid matter," the Yorkshire Act specifies it as "the solid refuse of or the sweepings from any manufactory, manufacturing process, brickyard, mine pit-shaft, quarry, workshop, or shop, or any bricks, stones, gravel, sand, earth, mud, soil, ashes, cinders, or clinkers, or any rubbish, or any deposit in a reservoir, mill-dam, water-lodge, or pond, or any sludge, or any soiled sewage matter, or any garbage or offal from a slaughter-house, or the carcase or portion of the carcase of any animal, or any solid matter."

Liquid sewage "includes any liquid of an excrementitious character, blood, and the washings of a slaughter-house which contain blood."

In respect of procedure against pollutions of the foregoing character, this Act has effected a salutary change for summary procedure. It is not necessary to have the consent of the Local Government Board for prosecution in the case of pollution by

solid matters or sewage. Part V. of the Act deals with liquid pollutions from manufacturing processes. In order to take proceedings under this section, however, the consent of the Board must be obtained; and after it has been obtained, the offender is only entitled to receive one month's notice that proceedings are intended to be taken, instead of two months as in the Act of 1876.

In respect of procedure, certain new features have been introduced. In the first place, offences under the Act may be prosecuted, and penalties, &c., recovered summarily before a Court of summary jurisdiction by the Rivers Board, or by any officer authorised on their behalf; (2) all penalties recovered are to be carried to the credit of the Rivers Board; and (3) costs of the proceedings shall be in the discretion of the Court, and paid as it shall direct. In the second place, provision is made whereby any officer of the said Board, or anyone duly authorised by the Board, on showing his written authority, may enter any lands or works as he may think fit for the purposes of his inquiry; and if he take samples of effluents proceeding through said lands or from said works, he shall be bound to take triplicate samples, one of which he shall leave with the owner of the works. And in the third place, obstruction to such an officer in the prosecution of an inquiry on the part of anyone shall be attended by a penalty not exceeding five pounds. Further, if the Local Government Board has reason to believe that the Rivers Board is not proceeding with due diligence, it may order such other proceedings as it thinks just. These provisions, barring the last, are not to be found in the General Act of 1876.

The main benefits accruing from this Act may be put briefly as follows:—(1) It centralises or focuses the authority who shall take action—namely, the Rivers Board; (2) it defines the various pollutants and classifies them, and catalogues their sources; and (3) it relieves the Rivers Board of the necessity of asking the consent of the Local Government Board to proceed against pollution by sewage or by solid matters, and, since the Act clearly embraces coal-washings among the solid matters, of summarily proceeding against such offenders.

In 1892 a Conservancy Board, composed of members of County Councils and of county boroughs, was formed, in order that uniform action might be taken. Soon after its creation, however, it was found the General Act was insufficient for securing effective

action, and hence its application to Parliament for the above Act, which we have considered in some detail.

Such, then, have been the legislative enactments on the question of pollution of rivers since the passing of the Rivers Pollution (Prevention) Act, 1876.

Short of this, however, there have been suggestions from time to time of amendments in the existing law, and also indications whereby, with the law as at present existing, but not in special legislation for rivers, the nuisance may be overcome. One of the most prominent of the advocates of the latter mode of overcoming the evil is a writer in the *Contemporary Review* for September, 1893, on "How to Stop River Pollution." This writer—Mr. Frank Spence—says, "I am convinced that until the outflows of all sewage works are placed under regular inspection by officers of the Local Government Board (just as chemical works are by the Alkali Acts) the difficulty with the local ratepayer and the polluter, who is a committee member, will not be overcome." He points out that inspectors have been appointed with like functions in many departments, and he instances the inspectorships of factories, mines, explosives, burial-grounds (in England), prisons, police, railways, canal-boats, asylums, schools of all kinds, and chemical works. He shows that the Alkali Acts have amply justified their place on the Statute Book, and that the standard of purity of chimney effluents therein laid down, and made progressive in severity as experience dictated, are well within the limit of the manufacturer, and compatible with atmospheric purity, since the reports of the inspectors show that in only three cases has it been necessary to institute legal proceedings, and on two of these occasions simply for neglect of registration. Here, then, in respect of air sewage, legislation has succeeded in rendering most efficient service against impurity of atmosphere. He further argues that all that requires to be done for sewage works would be to insist that sewage effluents into rivers should conform to a certain simple standard, and that such effluents should be tested by inspectors from time to time.

The test he proposes is to half-fill a clear glass bottle with the sewage effluent, to stopper it tightly, and to expose the bottle and contents to good light in an ordinary room, so that the contents should not give off an offensive odour when the stopper is withdrawn. This would satisfy him as to sufficient purity of effluent. He does not think that fresh legislation is needed to

prevent the pollution of our rivers. On the other hand, as he interprets certain clauses of the Public Health (England) Act, 1875, such powers already exist, and are vested now in the Local Government Board. They are to be found, he urges, in Clauses 293, 294, 295, and 296. Clause 293 reads as follows:—"The Local Government Board may, from time to time, cause to be made such inquiries as are directed by this Act, *and such inquiries as they may see fit in relation to any matters concerning the public health in any place*, or any matters with respect to which their sanction, approval, or consent is required by this Act;" while Clauses 294 and 295 empower the Board to make the necessary orders; and Clause 296 provides that inspectors shall have all the necessary powers. In addition to the foregoing, he points out that Clause 299 gives the Board the oversight of sanitary authorities, and enables it, on the complaint of a single person, "that a local authority has made default in enforcing any provisions of this Act which it is their duty to enforce," to so order the defaulting authority to take procedure.

It will be observed that Mr. Spence solely confines himself to the pollution of a river by sewage, and it would appear as if the clauses of the English Act just quoted did cover the ground he traverses. In respect of sewage pollution solely, however, the Public Health (Scotland) Act embraces all the necessary powers, and actions that have been taken against polluters with sewage of water-courses with success, but it was necessary to ground the action on the water-course so polluted being a nuisance under Clause (b) of Section 16 of that Act. For example, in 1885 the the Local Authority of Edinburgh prosecuted one Henderson for polluting the bed of the Water of Leith, and it was held that the nuisance was proved, and that the offender was bound to take the necessary steps for cleansing the stream, "so far as within his property." So also in the case of the Commissioners of Govan *v.* Mackinnon, where it was complained that the defender discharged sewage into a burn. Although it was proved that the defender did not cause the nuisance, but that it came from a point higher up the stream, it was held that, in respect the nuisance was found on his premises, he was bound to abate the nuisance. Section 99 of the Scottish Health Act makes the duty of periodical inspection for "nuisances" compulsory on the local authority or by their officers; and where a nuisance comes into the area of one local authority from that of another authority, the former may call

upon the latter "to take all competent steps for removal of said nuisance, and the said local authority shall be bound to do so accordingly."

In respect of the fouling of a stream by sewage to the extent that a nuisance is created, it may, therefore, be considered that the law is at present sufficient, if set in motion. It has been already mentioned that the Local Government (Scotland) Act, 1889, by Sub-section 4, Section 11, vests in County Councils "the whole powers and duties of the local authorities under the Public Health Acts of parishes so far as within the county (excluding burghs and police burghs)." Herein lies one of the difficulties of carrying out the provisions of the Pollutions Act of 1876. In the course of almost every river in Scotland, the burghs are the chief polluters by sewage, and experience bears out the fact that such burghs refuse to conjointly move with County Councils for the carrying out of the provisions of the Act. Besides, it very rarely happens that a river, from its source to its outflow, is within the jurisdiction of one single County Council; more usually there is more than one jurisdiction. But there has not hitherto been any attempt in Scotland, so far as is known, to take advantage of Sub-section 3 of Section 55, which provides that the Secretary for Scotland, by Provisional Order, made on the "application of the Council of any of the counties and burghs concerned may constitute a joint-committee or other body representing all the counties and burghs through or by which a river, or any specified portion of a river, or any tributary thereof passes, and may confer on such committee or body all the powers of a sanitary authority under the Rivers Pollution Prevention Act, 1876, or such of them as may be specified in the Order, and the Order may contain such provisions respecting the constitution and proceedings of the said committee or body as may seem proper," &c. Such an Order must be confirmed by Parliament before it can operate.

There can be little doubt that Glasgow, which up till recently was, and to a considerable extent is still, a great sinner as a polluter, will be compelled, as soon as possible after it has succeeded in purifying its own sewage, to take such a step as this, or, preferably, to seek an Act of Parliament as was passed for the West Riding of Yorkshire; since being a county itself, and having within it only a small portion of a badly polluted river, and since part of its sewage is emptied into a stream in another county, it

could not act alone in any scheme for the purification of the Clyde. Until then, however, it is compelled to leave things alone, and what is true of Glasgow is true of similarly situated populous places. It is, therefore, little wonder that the provisions of this section have not been in demand.

We are now in a position to discuss intelligently the weaknesses of the Act of 1876, and to suggest wherein the Act should be amended.

It having been clearly demonstrated that the Rivers Pollution Act has signally failed in effecting any improvement on the condition of our rivers, it remains to be considered wherein it has failed. The causes of failure may be divided into two classes—namely, (1) those due partly to the inaction of local authorities; and (2) those inherent in the Act, and which are largely to blame for the inaction. Having already dealt with the former, let us now especially deal with the latter class.

I. In respect that the Act is *permissive*, it ought to be made a *compulsory duty* of local authorities to enforce its provisions.

II. That the restrictions are unnecessarily stringent. For example, it ought not to be necessary to obtain the consent of the Secretary for Scotland in order to prevent any one throwing or putting, or causing to be thrown or put, sewage or other excrementitious matter into any water-course. Not so much objection can be held to that consent being necessary in the case of liquid manufacturing discharges, for there ought to be a wholesome care that trade interests are not unduly harassed. In this respect, therefore, the provisions of the Act might be left undisturbed. A difficulty, however, will always arise as to what are the best practicable and "reasonably available means to render harmless the poisonous, noxious, or polluting liquid so falling or flowing, or carried into the stream." This must, however, eventually be faced. It fortunately happens, however, that by the co-operative action of manufacturers who have willingly carried out suggestions for the purification of their trade discharges, a large experience has been gained towards the solution of this knotty question. We have already given examples of this in respect of print-fields, dye-works, paper mills, and paraffin-oil works, and the Glasgow experience of precipitation treatment of sewage demonstrates how efficiently that compound fluid of city sewers may be purified. The dictum of the judge already quoted may be taken as the standard of purity in which an effluent may be discharged into a river.

It seems an unfortunate fact that "*solid matters*" of the Act *should not include particles of matter in suspension in water.* Such an interpretation nullifies, to a large extent, the purposes of the Act. For example, a fine particulate matter like coal-dust is in suspension in water for a varying distance after it enters the stream, which distance will depend on the relative volumes of the stream and of the effluent; if, for example, the stream be low, it will fall to the river bed in a shorter distance than if the stream be in flood. And it would appear as if advantage is taken of that fact. Since, however, all matter, unless of less specific gravity than water originally, suspended in the water of a stream will, sooner or later, be deposited in the bed or on the banks of a stream; and if the quantity of matter originally suspended be large and be continuously added, sooner or later the bed and banks will become offensive to the eye, and always be useless for primary purposes, and will ultimately interfere with its due flow. Moreover, it never can, in this condition, be useful or suitable for the drink of animals.

This blot in the Act of 1876 has been removed from the Yorkshire Act by distinctly defining what solid matters put into a stream become a nuisance; and amongst these is clearly named "the solid refuse of any mine pit-shaft, unless it be in the condition in which it was drained or raised from the mine pit-shaft or quarry, or have been passed through efficient settling tanks in connection with any coal-washing machinery." And since coal-washing has of late years become a large industry, and is productive of much river pollution, the Act of 1876 should be amended in like manner.

This brings us back to a standard for effluents. It is the decided opinion of many of those engaged in the administration of the Act of 1876 that, in respect such a standard of purity was left out, the efficiency of the Act for administrative purposes is seriously impaired. As has been said, the Commissioners in 1870 were impressed with the fact that such a standard was necessary, and none were better qualified than they to pronounce on the fact, and on what was a reasonably fair standard. That they believed it necessary for the repression of river pollution, and that it should be an important constituent part of the Act, cannot be doubted from the pains they took to make it workable, and from the opinions they took of others as to its fairness and practicability. There is abundant evidence now to show that a standard effluent

can be arrived at for a particular industry, as in the Addiewell case, and also from the work of the Rivers Commission.

It is highly desirable that an amendment in the present Act should be made in establishing a standard effluent for all rivers. That the difficulty is more imaginary than real is proved by the success of the Alkali Acts, which established such a standard of purity when first put before Parliament. Let there be established some standard effluent for all polluting liquids, reasonably fair and minimal, if thought desirable and necessary, as was the case in the Alkali Acts, and let it be more exacting as experience ripens, as was also the case with those mentioned Acts.

We may well copy some of the other provisions of the Alkali Acts in order to purify our rivers, as these Acts, in one particular, purified our atmosphere.

In the first place, there should be a compulsory register of all works—including individual houses, hamlets, villages, &c.—of every kind which discharge, or have the opportunity of discharging, polluting substances into a water-course, be they solid or liquid. Indeed, it would appear as if some such provision of this kind had been contemplated in the Rivers Pollution Act itself, for in the preamble we read, "Whereas it is expedient to make further provision for the prevention of the pollution of rivers, *and, in particular, to prevent the establishment of new sources of pollution.* Be it enacted."

In the Public Health (Scotland) Act, 1867, provision is made whereby, in the contemplated establishment of an offensive trade, such as that of blood-boiling, tanning, slaughtering of animals within a burgh or village, or within 500 yards thereof, the consent in writing of the local authority must be obtained and published in the newspapers of the district. No such provision, or even like provision, was laid down in the Rivers Act, hence a public work might be established on or near the banks of a stream, and might pour its objectionable effluents into the stream without any consent being asked or obtained. If such a compulsory register as has been indicated were made, and if the registering authority were to be the County Council, their authority would be exercised *ab initio*, and new pollutions, at least, prevented.

Administrative experience has compelled not a few to put this forward as a reasonable amendment.

Granting, however, that such compulsory registration had been established, it is obviously necessary that an officer or officers of

inspection would require to be appointed for the purpose of seeing that the provisions of the Act were being consistently carried out. The duty of such an officer should be strictly confined to this, as there would be plenty to do. As a matter of fact, this has been done in the Yorkshire Act; not only so, but a special medical officer has been told off for this special duty. This could only be reasonably possible where a Conjoint Committee or Conservancy Board had jurisdiction over a large area of county, as in Yorkshire.

Once more. In respect that no penalties have been attached to offences in the Act of 1876, such should be introduced into an amending Act on the lines of the Yorkshire Act, for, unquestionably, the mere presence of such penalties in an Act of Parliament have a deterrent effect.

The time is now ripe for public steps being taken for the amendment of the Act of 1876. History and experience equally demonstrate its unworkableness and impracticable character. Parliament itself has acknowledged it in the Acts for Lancashire and Yorkshire, already dealt with, and all that now remains is strong representation by such a society as this, coupled with a popular movement, to bring about a reform which is now acknowledged to be necessary alike by rural and urban communities, and by those who have to administer the present Act.

V.—*The Literary Art of Robert Burns.* By James Colville, M.A., D.Sc.

PRESIDENTIAL ADDRESS.

[PHILOLOGICAL SECTION.]

[Read before the Society, 3rd February, 1897.]

(With Lantern Illustrations of Handwriting, MS. Readings, Spelling, Emphasis Marks, &c., &c., most obligingly prepared by Mr. P. Falconer, a Member of Council.)

The attention which the career and genius of Burns have drawn to him as a great social personality has exaggerated the merely incidental interest of his life, and diverted scholarly attention from his work, viewed as a literary product. The literary art of Burns—the sources, character, and content of his diction, as well as his training and workmanship as an author—has never received that treatment, by study or prelection, which has done so much, both here and still more in Germany, for Chaucer and Shakespeare, not to speak of the strictly classical authors. What can philology do for Burns? What can textual criticism do to teach the nature, rise, and progress of his craftsmanship or technique? Was he an educated author, or merely a clever peasant whom press readers and editors have made presentable?

One of Burns's many plans was to sketch his poet's progress. "To know myself had been all along my constant study," he says; for he had his delusions, and of these the capacity for self-introspection was certainly one. He never worked out this plan. Can the omission now be supplied? His career naturally divides

Note.—The contents of the Kilmarnock MSS. are given in "Scott Douglas," vol. VI., p. 377. He thinks they originally belonged to the First Commonplace Book (April, 1783—October, 1785). They are in the Kilmarnock Burns Museum, and accessible to anybody. The Irvine MSS., fewer in number, must have been the press copy used for the Kilmarnock edition, 1786. They are the property of the Irvine Burns Club, and in the custody of the Town-Clerk, Mr. David Dickie, who is most courteous and helpful to students of the poet. The Commonplace Books are private property and carefully guarded. Readings given in this paper, if not specially indicated, are from MSS.

The criticism of Scott Douglas's work, in the following pages, is not to be misunderstood. Few editors have done so much to earn the gratitude of Burns students. Special comment upon his work is itself a distinction.

itself into three periods—preliminary attempts at authorship, the discovery and working of his special *métier*, his acknowledged repute as a living author. The last may be set aside as too artificial and self-conscious to suit our point of view and present purpose. Let us limit ourselves to that notable July of 1786 when the Kilmarnock edition appeared, and here again mainly to that period of enormous literary activity—on which, indeed, his enduring fame is based—when he was day by day crooning to himself at the plough-tail on the lea-rigs of Mossgiel, or feasting his fancy on the humours of Ayrshire farm and village life.

These early days of his remind us of the Elizabethan "singing birds" when Shakespeare was best known for "his sugared sonnets among his private friends." So Burns crooned and scribbled, transcribed and gave away his verses at the call of kindred sympathy or good fellowship—

> "Some rhyme a neebor's name to lash;
> Some rhyme (vain thought!) for needfu' cash;
> Some rhyme to court the countra clash,
> An' raise a din;
> For me, an aim I never fash;
> I rhyme for *fun*."

Burns is too often the literary *poseur* in his prose, rarely in his native Doric. Here, therefore, we have the first impulses of his art, as we see him, "ben i' the spence," filling the fair well-written folio pages of the first Commonplace Book, begun in the spring-time of 1783, or transcribing from his note-book the contents of the Kilmarnock MSS., or touching up the Irvine MSS. for the printer, and stepping out proudly along the Kilmarnock Road with press corrections for John Wilson. Here we have indubitable evidence at first hand of the poet's craft, and, if we cannot catch him thinking, we, at least, make the nearest human approach to it. It is a wonderful revelation of impetuosity and power—this eager hurry that outruns his "spaviet Pegasus," dashes down a hasty syllable or emphatic capital before its time, or lends additional force to word or phrase by a larger sweep or firmer underlining.

What do we know of the "Schools and Schoolmasters" of his 'prentice time, for, after commencing author, serious study, never congenial to him, was scarcely possible? The direct evidence on the point is his fragment of autobiography, and the statements, at a much later date, of his brother Gilbert and of his teacher, Murdoch. The first has all the faults of the age. Scarcely any

man of that period, conscious, rightly or wrongly, that he was born to greatness, could give a direct, natural, and unaffected account of himself and his personal surroundings. Burns, introducing himself (1787), through Moore the novelist, into the circle of gentlemen who write, and accounting for himself, is the Burns of the autobiography. It is possible, however, to extract from it what seem to be matters of fact. "By the age of eleven," he says, "I was a critic in substantives, verbs, and participles. . . . Tho. I cost my schoolmaster some thrashings, I became an excellent English scholar." But this is the man of thirty recalling the boy, and that not accurately. What grown man can resist the temptation to romance over his schoolboy days, especially if he can drag in *Orbilius plagosus* and his own heroic defiance of authority?

His reading appears to have been extensive—most of the sentimental and learned work of the time, indeed, but this tasted rather than studied. Masson's "Collection" formed the bulk of his early library. A modern Board-manufactured scholar, getting the gems of his country's literature for nothing, would turn from it in disgust. In unattractive guise it introduces historical and sentimental anecdotes, improved, *à la* Richardson, to touch the heart of the embryotic scamp, superficial dilutions of Bible and Roman history, the epistolary correspondence of such precious people as Pope and Mrs. Rowe. To redeem it, and form a young stylist, there is much from the *Spectator*. The greater lights are represented by a few speeches from Shakespeare and "Paradise Lost," good specimens of Pope and Addison, Thomson and Gray, while, *longo intervallo*, come Shenstone, Parnell, Beattie, Mackenzie, Gay, Akenside, Home, and Macpherson. To "Masson" Murdoch adds a spelling-book, a grammar, and a Bible, and describes his method of teaching—syllabling, oral spelling, parsing, analysis. "They (Robert and Gilbert) committed to memory the hymns and other poems in Masson with uncommon facility, partly owing to the method pursued by their father and me, which was to make them thoroughly acquainted with the meaning of every word in each sentence that was to be committed to memory. By-the-bye, this may be easier done [Murdoch's English is not immaculate] at an earlier period than is generally thought. As soon as they were capable of it, I taught them to turn verse into its natural prose order, sometimes to find synonymous expressions for poetical words, and to supply all the ellipses. These, you know, are the means of knowing that the pupil understands

his author. These are excellent helps to the arrangement of words in sentences, as well as to a variety of expression."

This admirable method could hardly have been bettered. Such an education in English was not within the reach of Scott, though an Edinburgh High School boy. It is, indeed, questionable if we are so well served even now. Well might Gilbert say—"Murdoch was a principal means of my brother's improvement." The only regret is that the pupil was but six and the teacher eighteen. A year and half was all they had of Murdoch, except three weeks when Burns was fourteen, and that mainly devoted to French. Fortunately William Burnes was a man of quite exceptional intellect and force of character. Gilbert's account is more moderate —"With Murdoch we learned to read English tolerably well, and to write a little. He taught us, too, English grammar. I was too young to profit much from his lessons in grammar, but Robert made some proficiency in it." And then he tells us of the boy's enormous appetite for books, unluckily with but little to satisfy it, which we can well believe. The brief report with which Robert opens the first Commonplace Book is equally restrained. Of its author he says:—"As he was but little indebted to scholastic education, and bred at a plough-tail, his performances must be strongly tinctured with his unpolished, rustic way of life." Then he becomes sentimental. "For my own part I never had the least thought or inclination of turning Poet till I got once heartily in Love, and then Rhyme and Song were, in a manner, the spontaneous language of my heart." The first piece he gives, "Handsome Nell," is followed by a critical estimate of its quality. In his rhyming, poetical epistles he is in quite another vein:—

"I am nae poet in a sense,
But just a rhymer like by chance,
An' hae to learning nae pretence,
Yet, what the matter?
Whene'er my Muse does on me glance,
I jingle at her."

This sane enough estimate of his art in its genesis and quality, without love and heart in capitals, forms the other extreme to the sentimental exaggeration of the autobiography.

By the time he had reached his majority he had amassed a very creditable capital for author-craft. He used it with ease and grace as occasion required. In English he could play the "sedulous ape" to Murdoch, whose "argillaceous fabric" or

"tabernacle of clay" is the "auld clay biggin'" done into very passable Johnsonese. Such phrases he could reel off at any time. Milton, Shakespeare, Pope, and Gray, and, above all, the Bible, he could quote when required; but this as little bespoke a grasp of their real inwardness as his liberal use of French phrases showed a mastery of the language. In reality he was of the true Shakespearean stuff. With the ease and audacity of the *erne* he swept the mere of learning and secured the big fishes from sovereignty of nature.

> "I think, he'll be to Rome,
> As is the osprey to the fish, who takes it
> By sovereignty of nature."—*Coriolanus.*

Thanks to keen intellectual curiosity, quick sympathies, vivifying imagination, and consummate mastery of phrase, he could always give points easily to the stirks that came out of college to bray like asses.

During his 'prenticeship he completely realised the Baconian guide to self-culture—"Reading maketh a full man; conference a ready man; writing an exact man." Books he read eagerly. His Commonplace Book and his well-written MSS. tell their own tale of the virtue of exactness. "My social disposition," he says, "like our catechism's definition of infinitude, was without bounds and limits." Of the debating clubs he was the moving spirit, and this not only at the evening gathering at Tarbolton or Mauchline, but weekly at the kirk stile. Out of the debates to the ding-dong of the kirk-going bell, and the din over auld and new licht came the revelation of inborn powers. Scotland owes a far greater debt for cherishing a healthy intellectual life to Calvinism, the catechism, and long sermons, than to all her parish schools put together. The outcome needed but close contact with the realities of life, and this came, about the poet's twenty-third year, with the Irvine business failure and the Armour entanglements, forcing him to call upon the undeveloped talent which the country-side had applauded.

Had worldly success followed, the tastes and studies of the earlier period, combined with what we know of subsequent ambitions and abortive literary plans, would lead us to expect in Burns only one more added to that gallery of Scoto-English authors of whom Home, Beattie, Robertson, Hume, Mackenzie, Blair, and their compeers are the brighter ornaments. Had Burns been content to be an English author, the result may be guessed by comparing the rhyming epistles with the labour of the file which turned out the "Hermitage" lines

the "Wounded Hare," and the "Epistle to Graham of Fintry." Dr. Moore advised him, after the success of the Kilmarnock edition, to write henceforth in English. Luckily he took his own way with good advice of this kind, the way of a gentleman and a true artist. He thanked his mentor courteously and naturally, but followed the bent of his own sympathies. Quite half-a-dozen of his contemporaries wrote as good or better English. It was his to be the greatest master of the vernacular the world ever has seen or ever will see.

His confession to Davie, that he was a rhymer by chance, is disingenuous. Diligently had he sought for an aim and style, and found it. Luckily he kept the Beattie-Shenstone-Mackenzie style for special enjoyment as an acquired taste. Gray and Goldsmith might have made poetry out of abstract nouns written with capitals, but that would not do for Burns. He turned to his true masters, Ramsay and Fergusson. A warning finger was over their English verse, but their *plain lallans* went straight to his heart—

> "Then farewel hopes o' Laurel-boughs
> To garland my poetic brows!
> Henceforth I'll rove where busy ploughs
> Are whistling thrang,
> An' tell the lanely heights and howes
> My rustic sang."

Now that he came to see what environment and genius had done for him, did he write Scotch? The question requires qualification. If literature of the vernacular means the language, thought, feeling, natural to common people as they speak, think, and feel, such a product would be an impossibility. The poet is a *Makkar*, a *Dichter*, and must be free to select, combine, idealise, as his plastic imagination dictates. But the mind and art of Burns are not now in question. It is rather the technique which guided and perfected the expression of these. Now, as Burns was a Scottish rustic, ever in touch with the soil, but one who had educated himself on the best English models, the question resolves itself into another. How far was his vernacular influenced by English—that is to say, in what respect is it a contribution to the larger body of English literature? Does he stand among the immortals because he wrote with superb distinction the speech that Shakespeare wrote? If yes, then patriotism must be consoled with the thought that he was like the Scot abroad, who, while extending the empire with sword and plough, is ever true to the heather and the thistle

at home. Whatever the answer may be, it has to be reached through a philological inquiry into the text, embracing a study of hand-writing, grammar, spelling, punctuation, and vocabulary.

We have quite a mass of illustrations of his MSS. The series opens with the boyish attempts of a lad of thirteen, and the later efforts of a lover who is longing for "ane-and-twenty." It closes with the tremulous, but bold and clear effort, of a man stricken with the hand of Death. With the writing of no author or historic personality is the public so familiar, after that general fashion which prompted the remark of a visitor to the Centenary Exhibition. Taking in the MSS. room with the one comprehensive glance of the uninformed, he exclaimed, "These are his writings, but when you see one you see them all." They will reward close scrutiny, however, and yield some fruit, not yet gleaned by the many editors who must have read them, towards textual criticism. If a bold, characteristic hand be a test of a cultivated and capable intelligence, Burns comes out with flying colours. His hand has always the air of distinction, and must have evidently been a source of pride to him. It offers a marked contrast to that of most of his correspondents, notably his brother Gilbert's, which is feeble, shaky, and angular, with decided German features of a narrow parallelism. That of his eldest son, Robert, is still more weak and colourless. The get-up of the MSS. offers a marked contrast to that of Allan Ramsay, who does not even indicate his lines by capitals, spells with untutored freedom, and is quite indifferent whether proper nouns have capitals or not.

In hand-writing the poet has his likes and dislikes. These are well shown in his abundant use of capitals, for it was the fashion of the day to employ these far more largely than now as a mode of marking emphasis. Many of the capitals, notably *A*, *C*, *D*, *E*, *G*, *I*, *S*, *Y*, he treats consistently in bald, colourless fashion. His special favourites, *B*, *F*, *R*, *T*, he always dashes off with ease and distinctness. A few are such special favourites that he keeps two styles on hand for appropriate occasions. The first vowel, in bald, triangular shape, leads a line or sentence. In other positions an enlarged ordinary *a* generally does duty for it. This latter grew upon him towards the close, and was always prominent in the letters, for these mannerisms at many points afford a key to the age of a MS. His two *P*'s are precisely analogous. With pet words like *Poet* and *Poverty* we have a whip *P* with butt up and the long lash looped in two full sweeps round the handle. *Bard* is

favoured in similar fashion. The ordinary *p* enlarged is good enough for Willie Pitt, and for any but the leading place. Other double forms are *M*, *N*, and *W*, but for the two first the simpler style is preferred all through. For the last the enlarged ordinary *w* is decidedly predominant in later MSS. Full use is made of the elaboration of which *H* and *K* admit, and these are never varied. As a rule *L* is simply done, but in *Love*, *Labour*, *Lasses*, it has enlarged loops at the terminals.

The small letters are similarly individualised. The most prominent, a long *s*, was a fashion of the age, both in script and type. In early MSS. Burns reserves it pretty generally for a position between vowels or before a long consonant like *p*. The habit of using it as initial grew, but at no time is it final, nor does it follow a long consonant anywhere. The fashion was giving way near the close of his career, but it held on well into the third quarter of this century. Small *d* has also two forms, the upright limb straight or with a backward sweep. The latter is rare in Kilmarnock and Irvine MSS., and there only final. *Tam o' Shanter* and *Jolly Beggars* have a great many, but towards the close of the former poem, where a graver style comes in, the ordinary *d* is reverted to. Nor is it at all common in the first Commonplace Book, but the later Edinburgh one, as well as the letters, has a great many.

A still better test of the age of the MS. is the small *r*. Burns, in his youthful, amateurish days of careful finish, used an *r* which was but the body of small script *k* apart from the limb. This is distinctive of his Burness signature and of many pieces in the Kilmarnock MSS. It is rare elsewhere, and only where there is special care, as in the name *Glencairn*. The easier form marks the prose throughout. In all the letters there is a tendency to a general forward movement of the pen, throwing the letter often out of slope. Looped letters, up or down, are very rare. In the very early Alison Begbie letters, however, and the closing ones, written feebly at Brow, even *t* is looped. Long *s* is looped only below the line for the most part. Burns has a slight break at almost every letter, even where it would be most natural to run on. He has an objection to curving up letters at their terminals, thus *t*, *d*, *y*, *g*, finish very abruptly.

As a rule the penmanship is singularly free from slips. Deletions are unknown unless in the reader's hand in the Irvine MSS., in view of the Kilmarnock press. Erasure is seldom resorted

to, and then only by a slight blurring of the peccant member. Omitted letters are rarely inserted, so that if the poet re-read his MS., he did not *fash* himself over such trifles. When he makes such slips, the long letters are always responsible—*e.g.*, *c'amorous*, *ni'gted*, *sq'eel*, *a'tho*, *cu'st*, *vint'er*, *St. Step'en*, *a'tidote*, *worsship*, *len'th*, *mis'pending*, *madamoisselle*, *misstress's*, *s sacred*, *lest* for *less*, *blesst*. The Irvine *Cotter's* is most carefully written, yet it has some curious slips. In *heart-felt* the *f* is repeated before *t*, and *l* simply written over it. The phrase *warfare wage* has begun with *wag*, and then *r* is written over the *g*, showing how the poet was upset by having his rhyme in his mind. Long *s* has bothered not only the poet but his editors. In *Halloween* there stands the line—

> "They hoy't out Will wi' sair advice."

No one has seen that *sair* is here nonsensical. A look at the MS. shows undoubtedly a long *s* written over a faint *f*. The poet's first thought (*fair*) was sense, the second nonsense. This is one of many proofs showing that, if he ever took the trouble of revising in script or type, it must have been in a very uncritical fashion. Again in *Holy Fair*, Kilmarnock MS. has—

> "Then sairie Willie Water-fitt
> Ascends the holy rostrum."

The epithet here most probably is but a variant of *sorry*, indifferently good. Scott Douglas, describing this MS., and professing to reproduce it for the student, reads *fairy*, without seeing the absurdity of it, to say nothing of his gratuitous change of termination.

As grammar, punctuation, and choice of words are integral parts of an author's style, his text ought to give evidence of their quality. When, as in the case of Burns, the printed text can be so well supplemented by MSS., features which never see the light are revealed, showing us the very workings of his mind, the craftsman in his workshop. There we can study his historically and critically interesting spelling, emphasis marks, capitals. All these are lost in type. As for the poet's punctuation, it is as correct as the press reader can make it. Now this completely obscures the idiosyncrasies of so wayward an author as Burns, and puzzles the student who is labouring to see a meaning in them.

Nor is the editor able to shake off this servile adherence to convention when claiming all the virtues of scrupulous accuracy and fidelity in a reprint. The best of them is M'Kie's reprint of the

Kilmarnock edition, yet here are the variations got from one reading of it alongside of the original :—

Kilmarnock Edition.*	M'Kie's Reprint.
Contents.	*Contents.*
. . . Salutation to his auld Mare	. . . Salutation, to his auld Mare
Page 18.—Wi' dissipation, feud an' faction !	Wi' dissipation, feud, an' faction !
,, 47.— . . . style, an' gesture	. . . style, and gesture
,, 66.—Poor Mailie's dead !	Poor Mallie's dead !
,, 77.— . . . solemn basses ye hum away.	. . . solemn basses, ye hum away.
,, 82.—I fear, that, wi' the geese,	I fear that, wi' the geese,
,, 85.— . . . she'll discern your hymeneal charter.	. . . she'll discern, your hymeneal charter.
,, 113.—Repeat it three times and the third time.	Repeat it three times; and the third time.

These are trifles, but the pretensions of the editor provoke such criticism. At the other extreme, as a disgracefully careless bit of work, is the Greenock reprint (1872) of the first Commonplace Book. Its pretensions are of the highest. The actual work is full of blunders, like *a'e* (always), *winna'*, *t'ween*, *we'el*, *while's*, *fau't*. Burns uses contracted *and* throughout, and this reprinter has it consistently in full. He has always *tho'*, too, for the *tho* of the text. Scott Douglas, with the MS. before him, rebukes the carelessness of his predecessor, and then gives professedly a faithful reprint, but he too falls far short of his pretensions. Both have the dishonest trick of correcting misspelling and ignoring deletions. Scott Douglas devotes two pages to admirable facsimiles of the MS., for which one cannot be too grateful, and these alone are enough to expose the errors of his own, professedly immaculate, reprint. The second Commonplace Book, again, has been reproduced by Professor Jack in *Macmillan's Magazine*. He rightly condemns Currie's mangling of it, but he, too, fails to reach his own standard.

The work left behind by Burns in script or type enables us to test his own estimate of his preparation for authorship, namely, that he was an excellent English scholar. Currie, his first editor, an educated Scot long settled in England, who saw more than any other of the poet's MSS., admits that he had to correct when editing, but this was never extended to "any habitual modes of expression, even where the phraseology may seem to

* This would be a credit to any press. Edinburgh edition, 1787, is inferior in every way.

violate the delicacies of taste or the idiom of our language, which he wrote in general with great accuracy." Though this is a poor apology for Currie's unwarrantable liberties, it has value as the contemporary opinion of a man of culture. The poet's own standard for his author-craft he gives in a letter to Mrs. Dunlop—"As to Poetry, when you prepare it for the press, you have only to spell it right and place the capital letters properly. As to the punctuation, the printers do that themselves." That his spelling was not hap-hazard is further borne out by a note that he sent to Johnson, to correct *Tobbacco* in a proof of an article in his hands on "Pipe and Tobacco." We may assume, therefore, that the spelling of his MSS. is what he had trained himself to practise as the usage of the period. Now the high-water mark of last-century printing in Scotland is seen in the beautiful edition of Gray's Poems, by the brothers Foulis of Glasgow (1768). Here are some of its peculiarities for comparison with modern usage or the spelling of Burns:—

cuckow	surprized	gulph
ardor	croud	drest
frolick	stir'd	chear
favourite	rowling	drop'd
controul	etherial	cloathed
compleat	warriour	antient
recompence	desart air	has broke
at other's wave (*verb*)	waiward fancies	Flattery sooth (*v.*)
	no farther seek.	
insect-youth	gayly-gilded	quick-glancing
infant-mind	Tyrant-Power	saphire-blaze

BURNS' COMPOUNDS.

Labor-sair	Heart's-blood	Sair-wark
Rural-life	Auld-age	Patriot-Bard (corrected over small *b* by the reader of Irvine MSS.)
Pictur'd-beuks	Fragrance-beauty	
Guid-bluid o' old Boconnock's		
Human-Race	wee-bit ingle	wee-things
Human-bodies	Magic-wand	Skelpie-limmer's-face
train-attendant	saut-tears	red-wat-shod

This and other models, which Burns must have studied in boyhood, will prepare the way for his own peculiarities:—

BURNES' CATECHISM.*

adressing	beleive	fabrick	favour

* The family Bible has, in his hand-writing, *douther*, which is Kincardine, not Ayrshire, *dōther* (daughter).

Masson's Collection.

centre	chrystal	desart	splendor
cheers	crouds	etherial	tyger
cheerfully	controul	fervour	uncrouded

Gilbert's Letter to Currie.

difficultys	licience	œconomy	our's
english	of (for off)	oppertunity	synonemous
labor'd			

Hamilton's Wallace (English verse).

Air (town)	chiftain	inviron'd	splendor
arbitriment	cliver	independent	Syrens
Barrons	curry'd hides	oblidged	tyes
beautify'd	controul	pannic	nation's joy
chearful	duly	rowls, rowl'd	Wallace father
chused	forsee	sirname	

Fergusson.

aukward	dy'd (died)	harrass	Phoebus
chearful	deny'd	have chose	pityless
chrystal	enchant	heart ake	rude ax
chrystaline	'ere	inchanting	splendor
clangor	farewel	inkindled	sooths (*v.*)
controul	fault'ring	invenom'd	your's*
croud	groupe	on's chariot *born*	

We have here the Catechism of religious belief drawn up by old William Burnes, and written out in a careful hand by Murdoch. Gilbert's letter to Currie shows how the less-gifted brother profited by instruction. The books of the poet's school-time—Masson's "Collection," Hamilton's "Blind Harry," and Fergusson—have features of spelling which partly agree with Burns, partly not. The beautiful edition of Fergusson, by Morison of Perth, has, like Burns, the noun-ending *-or* instead of *-our*, the use of *in-* instead of *en-* as a prefix, the persistence of *y* in *pityless*, *deny'd*, and the blundering *your's*. *Phoebus* here is right, a word which Burns spoilt, like *Cæsar*, after his printer had corrected it, always writing them *Phebus* and *Cesar*. Indifference to the elision mark may account for his *thro*, *tho*, and the like, when it was right in print, but he observed it in *ev'n*, *clam'rous*, and the like, according to the prevailing mode of printing verse. [I am glad to see that the modern printer has given up this device.] His proper names

* Modern forms occurring in these lists are there for comparison with the usage of Burns where he departs from his models.

sometimes showed indifference, as Willie *Pit*, "gab like *boswel;*" sometimes his spelling was phonetic, as *Isiah*, *Livistone.*

Burns' English Spelling.

heart achs (*verb*)	critisism (slip)	interupted	recompence
heart ake	controuling	integritive	suspence
ardor	distic	intirely	sooths (*v.*)
athiest	defficient	confering	superiour
aweful	Dasswinton	Ben Johnson	Scotish (not al-
family bible	dependance	literaly	sinfull [ways)
artic	detesteble	labor	squallid
agreables	duely	manuel	tyes
a equal	deporment (slip)	meerly	tottaly
akward (phonetic)	english	mantain	unforseen
bony lass	expence	Madamoisselle	untill
blockead (slip)	embarras	neighborhood	unexperienc'd
choaks	endeavor	oblidged	Vanburgh
commitee (phonetic)	facinating (slip)	priviledge	weakness's (*pl.*)
confidate (slip)	favor, favorite	pulvilised	prophane
chearfully	floor (flour)	puritannic	spy'd
center	farewel	Presbyterean	Theocrites
colledge	greeness	posession	Pit (Minister)
compleat	gager	reccollect (slip)	Dundass
beleive	honor	recieve	Phebus
chuse	her's, your's	recevieved (slip)	Cesar
croud	harras	rememberance	Mamon, Isiah

Many forms in this list, which is not, however, exhaustive, might be found in books of the period. A good London edition of the "Tale of a Tub" (1790) has similar irregularities, such as *croud center, compleat, chuse, expence, intirely,* showing that Burns's practice was that of the time. But the spelling of his day generally was much more regular and modern than anything to be inferred from these MSS. Nor is it possible to acquit Burns of that want of accurate observation in words which his own standard sets up.

Burns gives Mrs. Dunlop the impression of indifference to commas, but here he is certainly posing. His MSS. are scrupulously punctuated—the Kilmarnock very sparingly, the Irvine more freely. A few points are added or altered, not always wisely, in the Kilmarnock edition, but, on the whole, it very faithfully preserves the poet's interpretation of his own sense, much more so than many modern editions. He has few points that actually spoil the sense, but he errs now and then both by excess and by defect. A detachable phrase, now requiring two points, he lets off with one, and that always at the close. A phrase of address he leaves undetached by a point. A series of adjectives before

the same subject he does not peg off in detail as we now do. An emphatic adverb beginning a line he likes to follow with a comma, whether wanted or not by the sense. Strangely, though so fond of emphasising his text, he is careless and weak with the exclamation mark. Even direct queries he does not indicate at all. He never has an accent mark in verse, except *Scotlànd* in the *Queen Mary*, and very rarely such an underlining as this in the *Jolly Beggars*—

> " And *by* that Stowp! my faith an' houpe,
> And *by* that dear Kilbaigie."

An author's English must, above all, possess the quality of clearness, and to this nothing is so inimical as defects in syntax or the arrangement of words and clauses. That Burns occasionally violated this necessary rule, the following specimens, faulty either in grammar or in the use of words, will bear out. He was not himself so sure of his tread here as in dialect. In the autobiography, speaking of one of his early loves, he says, "My scarcity of English denies me the power of doing her justice in that language."

BURNS' ENGLISH.

1. Tho. *I cost* the schoolmaster some thrashings, I made an excellent English scholar.
2. There was a certain period of my life *that* my spirit was broke by repeated losses.
3. It is not *commonly* at these green years that the young nobility and gentry have a just sense, &c.
4. Every man, even the worst, *have* something good about *them.*
5. Had my father continued in that situation, I must have marched off to *have been* one of the, &c.
6. The story of *Wallace* poured a tide of Scottish prejudice *in* my veins, &c.
7. Tell Miss Jenny that I *had wrote* her a long letter.
8. *At these years* I was by no means a favorite with anybody.
9. *I am got* under the patronage of—so and so.
10. My father was just saved from *absorption in a* jail.
11. *A tract* of misfortunes.
12. My mind is *rapt up* in a kind of enthusiasm to their, &c.

The last is instructive. It occurs in the Commonplace Book, and shows a confusion between *rapt* and *wrapped.* The list might be extended from the letters.

There is no doubt that Burns, in the earlier portion of his career, if he aimed at qualifying himself as a writer of Scotch, did little in the practice of it. His youthful songs are but make-believe vernacular, while his more ambitious verse of the period closely follows English models. But about 1782 his aim got a

new and congenial direction. The call of practical local needs in the church question revealed to him the capabilities of the vernacular, and the perusal of Ramsay and Fergusson* gave both impulse and direction. No books in all his library of authors have left such a deep imprint on his own lines as these native rhymes. Words, phrases, metres, subjects—all these he selected and recombined for his own purposes. Marlowe's "Plays," Hollinshed's "Chronicles," and North's "Plutarch" did not do more for Shakespeare than Ramsay and Fergusson for Burns.

Burns never knew much, if anything at all, of the old classical Scotch. He could scarcely have seen Dunbar without letting us know of it, while Hamilton's "Blind Harry," a feeble verbose imitation of Dryden's "Æneid," would have been pitched away could he have had before him a page of Barbour. Much had happened to break the continuity of the national literature. Under Renascence influences it became imitative and artificial, and so got out of touch with the popular speech. The troubles of the 17th century completed the estrangement. Drummond, Montrose, Stirling, Leighton, Burnet were mere anglified Scots. Ramsay's "Evergreen" paved the way for a national revival, but even he had no scholarly acquaintance with classical Scotch. Burns, however, knew little of Allan's work, such as it was, save "The Gentle Shepherd," into which the poet had dragged a few archaisms. By Fergusson's time the romantic movement was popularising antiquities, but his archaisms, more pronounced than Allan's, are even more forced and unnatural. For all such Burns never had much liking. He cared nothing for Grose's "fouth o' auld nick-nackets," befooled that pompous prig, the Earl of Buchan, and, had Fate willed it so, would gladly have had his fling at the Bastile. Unlike Scott, who was always proud of his pedigree, he was but a nameless peasant, whose blood, as with facetious exaggeration he puts it, had "flowed through scoundrels since the flood." Eschewing, therefore, the archaisms which Allan and Fergusson furbished up, he gave us a vernacular diction of his own, and this he found, where he got the best part

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* The *Autobiography* say, "Rhyming I had given up [winter 1781-2 in Irvine]; but meeting with Fergusson's Scottish Poems, I strung anew my wildly-sounding lyre." Yet, writing to Richmond in Edinburgh, February, 1786, he asks for a copy of Fergusson to be sent to him, evidently with the Kilmarnock edition in view, for he notes *The Ordination*, *Scotch Drink*, *Cotters*, and *Deil*, and adds, "Have completed 'Twa Dogs.'"

of his literary equipment, in the mouths of the common people. How this vernacular has survived through the centuries is a miracle. With Ulfilas it has more in common than with Douglas. Wyntown and Barbour are far more intelligible to the ear attuned to *plain lallans* than are Dunbar and Lyndesay. But one can follow the stream from the uplands of time—Laws of the Four Burghs, Acts of Scotch Parliament, Exchequer Rolls, Privy Council Register, Diarists of 16th and 17th Centuries, Kirk Session and Burgh Records. And at every turn we meet with the most direct, intelligible, and homely diction and idiom.

How did Burns treat his vernacular? A born stylist, he had many styles, and most of all in his Scotch. And ever as he grows in elevation and depth of tone, in width and spiritual insight, where the jocose, the shrewd, the caustic, or the tender, would be out of place, he leaves the vernacular behind, and expatiates in pure English. His contemporaries acted otherwise. They wrote in deadly terror lest a Scotticism should betray the porridge and the peat. Scott came under the same influences, and to this his many imitators have been true. The product of all his school is therefore of as little value philologically as the Highlander of the old-fashioned snuff-shop ethnologically. They all force the vernacular, as Burns did in his early efforts and frequently in his songs, into an English mould.

The internal evidence of MSS. and type goes far to show that Burns gradually gave his work more and more of a dialectic look. This is evident on comparison of the earlier Kilmarnock MSS. and Commonplace Book with the later Irvine MSS., and, still more, the early editions. The change was in some respects more superficial than real. At first, hesitating between English and vernacular, Burns used much that gives quite a Southron look to his verses. Thus final consonants are seldom dropped in words like *and*, *from*, *over* (as owre), *on*, *of*, *with*, *since*, *through*, *though*. As regards *and*, the Commonplace Book generally contracts it; but both Kilmarnock and Irvine MSS. agree pretty well over *an'*. There is a similar use of finals like *d* and *l*. The English and unmodified forms—*hands*, *stands*, *fend*, *moorland*, *highland*, *hall*, *fall*, *warld*—are notable in the Commonplace Book. Irvine MSS. and the Kilmarnock edition generally give them a Scotch look by elision, though the '86 edition has always *highland* and *moorland*. Burns grew to be more particular about the elision mark than he was in his early days. The Kilmarnock MSS. are conspicuously

indifferent unless in case of *its*, which is marked with the apostrophe even where it ought not to be, as in the pronoun *its.* The same practice is followed in Shakespeare's first folio. This mistake, in the case of *her's,* is on the very title page of the Kilmarnock edition—"Her's all the melting thrill." Yet edition '87 has the equally inexcusable—"Its no the loss," &c. Of course, by a false analogy, the rule is extended to *your's*, *our's*, and even to *wha's* in the Edinburgh edition. The Kilmarnock MSS. is similarly indifferent to the elision mark in *twas, twere, ha-folk, ha-pence, quo she, throuther* (*throw'ther* in type), *han-daurk, himsel.* It treats similarly *maist* (amaist), *mang*, and *yont*, which last is boldly supplied with the missing mark in Irvine MSS. Burns made his commas lightly, but in the Irvine press copy alterations are all in a heavy hand. Such a well-printed edition of Fergusson as Morison's of Perth consistently supplies an unnecessary apostrophe to *ere* (before). The Commonplace Book again is generally attentive to apostrophes, even in cases like *gi'e, li'e, lea'e, ta'en,* where they are quite unnecessary, but no MSS. show such a misuse of it as Scott Douglas's "o' his woe's," which is far worse than the poet's own *witness's* (plural) in his prose. The Irvine MSS. approach closely to the printer's practice, which in poetry of last century was conspicuous for helping the blundering ear in verse. In spite of custom, Burns in Kilmarnock MSS. has *every* and *even* in full, but *een* always unmarked both for *evening* and *eyes.* To the singular *e'e* he adds the mark. In *Halloween* (Kilmarnock MSS.) *so'ens* is correct, but in Kilmarnock edition it is, carelessly, *so'ns.*

The elision mark involves considerations of grammar as well as metrical euphony. In ignoring the mark for the possessive, Burns goes on historic grounds, for the apostrophe is modern. Old Scots writers treated these as true adjectives, and said "sister son." We still say "Lady Day." So also Burns in MSS. has *lordly Cassilis pride, auld wives fables, lairds lands,* and often, if he adds the *s*, there is no apostrophe, as in *Beatties wark.* In the *Borealis' race* of *Tam o' Shanter* the inserted apostrophe is a clear case of blundering.

In the verb, Burns has forms and idioms which are distinctively Northern. Thus he has many instances of its characteristic *-s* ending. All through its history Scotch vernacular has said *aa cyme, thu cymis, he cymis, we, ye, they cymis.* In the first person, if the subject, *I*, was emphatic, *-s* was not used. The vernacular

has always had this form in the dramatic present, *says I.* So Burns has, "Says I 'before I sleep a wink,'" changed in Kilmarnock edition to *Quoth I.* The *-s* of the plural represents the old English *-eth*, and old German *-et*. Shakespeare has this in "What cares these roarers for the name of king," "Winking Mary-buds on chaliced flowers that lies." This is exactly like Burns' "What sairs your grammars?" But he is not consistently Northern. In *Davie*—

> "How best o' chiels are whiles in want,
> While coofs on countless thousands rant,
> An kens na how to wair't"—

the rhyme compels him to drop the *-s* in rant, and the printer generally insists, for uniformity, on dropping it in *kens*, against the MSS.

Neither his printer, Wilson, nor Burns, "fash't a thoom" over historic accuracy. Wherever the printer encounters an old form, it generally goes. As for the poet, when his ear listened to the vernacular, he was right; when he aped English models, he was wrong. Thus in the Commonplace Book the opening lines of *Mailie* read—

> "As Mailie, an' her lambs thegither,
> Were ae day nibbling on the tether,"

instead of the Kilmarnock MSS. and even Kilmarnock edition *was*. In the Commonplace Book—

> "Croonin at a pleugh or flail
> Do weel enough,"

the poet has even missed his English rule. In the Kilmarnock MSS. *Do* is altered to *does*, but in another hand. In the Northern dialect *is* and *was* are generally preferred throughout all persons. Thus the *Earnest Cry* has—

> "In gath'rin votes ye wasna slack."

Even the Commonplace Book has in *John Barleycorn*—

> "There was three kings into the east."

On this Scott Douglas evolves, out of his inner consciousness, the statement that the poet could never be induced to change his bad grammar here, and adds the ill-informed rider to it that, with Shakespeare, he thought bad grammar a positive beauty. It was no thought of ornament, but true linguistic instinct, that made Burns write to Smith—

> "An anxious e'e I never throws
> Behint my lug or by my nose;"

or, again, in mixed form—

> "I here wha sit has met wi' some,
> An's thankfu for them yet."—(Davie.)

The old 2nd singular is still more frequent—

> "O Thou wha gies us each good gift."—(Lapraik.)

> "Thou paints auld Nature to the nines"—

or, in less serious company—

> "Thou clears the head o' doited Lear"—

and a plural—

> "For you that's douse an' sneers at this."

In English his foot is not so sure. Thus the prayer of the Commonplace Book has—

> "What Thou art surpassest me to know."

All these forms except the last, which is merely an English solecism, can be paralleled from old Scotch; only there they are regular, in Burns occasional. In most cases his idiom is quite English.

The future tense in Burns is often truly dialectic. While he is writing under English influence, as in the Commonplace Book, he does not use it. Compare the Commonplace Book with the Kilmarnock MSS.—

Commonplace Book.	Kilmarnock MSS.
I'll no insist	I'se no insist
We'll gie	We'se gie
We'll gar	We'se gar

Both have it, however in the familiar diction of *Mailie*—

> "Thou's get my blether."

Here we have only a corruption of the distinctive Northern *shall*. To this day in English the Scot prefers his *shall* to the southern *will*. Curiously Burns, even in his English prose, is as fond as Shakespeare of a true subjunctive. Thus in *Smith*—

> "I'll wander on with tentless heed,
> How never-halting moments speed."

Similarly in a prose sentence we have—"Till some squall overset the silly vessel," which Currie corrected to *shall overset*.

The participial forms give more trouble. The old present participle in *-and* was carefully distinguished from the gerund, as *falland, fallyng*. The loss of *d* and the universal dropping of *g* in participial endings in colloquial English have led to much confusion between the two forms. The change marked the transition from the older style of Wyntown and Barbour to the middle style.

In Burns the distinction between gerund and participle is noticeable. He uses *-in* always for the gerund—for example, "Croonin at a pleugh or flail," "For breakin o' their trimmer," "knappin hammers." The old present participle, which he found occasionally in Ramsay as *-and*, and always in Fergusson as *-in*, he has noticed so particularly as to head his glossary with a paragraph explanatory of the distinction. "The participle present, instead of *-ing*, ends in Scottish dialect in *-an* or *-in;* in *-an* particularly when the verb is composed of the participle present and any tenses of the verb to be." The spick-and-span punctuation here betrays the experienced hand. Whether the matter be that of Burns also or not, the rule has no reference to the poet's verses, for it cannot be made to square with the facts. In "Holy Fair," *glintan, hirplan, chantan, springan*, and in "Scotch Drink," *greetan*, all with verb to be, seem to bear out the rule. In *The Deil*, rhyme and rule require uniformity in one case, where, however, we have *thinkan, drinkin, linkan, jinkan.* When the participle is purely such, and makes no compound tense, there is the same irregularity. Thus we have *ramblan billies, auld folks crackan crouse*, as well as *glowrin een.* But, along with these, English *-ing* again and again asserts itself, especially if the word is clearly not Scotch. The MSS. do not help us much to Burns's practice. Kilmarnock *Holy Fair* has many *-ans* and *-ings* ; Irvine has a few *-ins* and many *-ings.* Its *glentan* has clearly been changed from *glentin*, showing a conscious effort at uniformity. The Kilmarnock *Twa Dogs* has but one *-an*; Irvine, 15; the former has 12 *-ins*; the latter, 6. Kilmarnock has only two *-ings*; Irvine, many. As a guide to usage over a longer period of the poet's career, Kilmarnock *Tam o' Shanter* has 6 *-ins*; Grose (edition '91), 7; '93-4 edition has not one, all *-ing.* Kilmarnock MSS. *Halloween* has very few *-ins*, mostly *-ans.* The Kilmarnock edition has a few of the Kilmarnock MSS. *-ings*, but mostly *-ans.* Where English influence is strong, as in *Cotter's*, Kilmarnock MSS. has several *-ings*, but only *strappin, sparklin;* Irvine has merely *blinkan, strappan*, the rest being *-ings.* In the Commonplace Book *-in'* with elision mark is general. If the glossary note is Burns's, then over the Commonplace Book he either knew nothing of the old Scotch rule, or thought the *-in'* the best compromise between Scotch and English.

Till the time of the Irvine MSS., he put the part as *-in* or *-in* with a few *-ans.* If he is responsible for the typography of edition

'87, he had fallen in with the prevailing printer's practice of the time, and given up *-ans*, even in a noun form like *messin* (a dog of Messina); but he keeps *spleuchan* and *pechan*. His reading of "The Gentle Shepherd" had shown him plenty of *-ans*, as *blinkan*, *brankan*, and even the pure form in *rowand* and *glowand*. Fergusson's printer, again, gives only *-in*, as *rantin*, *rowtin*, *cleedin*, *blinkin*, *todlin*, *slaverin*. This is undoubtedly the best practice. If the elision mark suggests *g*, then it is quite misleading and unhistorical.

The glossarial note says that the past tense and past participle usually shorten the *-ed* into *'t*. But this rule is no more uniform than the other. In speech both Scotch and English add *d*, *t*, or *ed*, whichever suits the final letter of the verb. The only difference is that, whenever possible, Scotch sounds the *-ed* as a syllable, and that as *-et* or *-it*. After dentals the Elizabethan rule, which drops the *d*, is followed in preference, thus—

> "Some cause unseen ay stept between,
> And frustrate each endeavour."—Carrick Farmer.

Cromek, who first printed this piece, did not understand this very familiar English usage (common in the *Authorised Version* of 1611), and made it *To frustrate*, which reading, of course, Scott Douglas follows, not seeing in such a case the beauty of what he thought the poet's bad grammar. In Wyntown's time the English *'d* was the rule, but Barbour prefers the far older *-yt* or *-it*, as *wallyt toune*, *grippit ay*, which afterwards held its own. Hence Burns rightly enough has *crabbet*, *rakket*, *respeckit*, *negleckit*. So fond is the spoken dialect of the full syllable that we have *pittet* (for *put* by the rule for final dentals), and even strong endings like *putten*, *hudden*, *hotten*, *sitten*. Burns's usage is here too uncertain. The Kilmarnock MSS. show a marked preference for *'t*, showing *letter't*, *crie't*, *pray't*, and even *fatigu't*. (Irvine has the conventional *fatigu'd*). Edition '87 changes *warsl't* to English printer's *warsl'd*, surely showing the absurdity of the elision mark altogether. The Kilmarnock edition generally has *-et*. Edition '87 always has *-it*. Irvine MSS. have many examples of *'d*, which is also characteristic of the Commonplace Book, and even the poet's early prose, so difficult was it for Burns to resist the printer's rule of his day. Thus Commonplace Book and '87 have *toss'd* for Kilmarnock MSS. *tost*. His *dropt* is also in contemporary English. In *Halloween* he brings the two forms together—"Liv'd and di'd deleeret." His preference for *'t* has passed over to such forms as *o't*, *for't*, *wi't*,

where the vernacular always sounds *'d.* He, too, frequently requires the syllable *-ed* to be sounded in verse, but never once marks it with an accent, rightly thinking that the reader whose ear cannot guide itself had better let poetry alone. Scott Douglas invariably adopts this un-English device, and is such a slave to his hobby as to mark *pacèd* when giving a *faithful* reprint of the poet's Commonplace Book, where there is nothing of the kind. In truth, poetry, a literary form for ages before writing was invented, is so entirely dominated by the ear and not the eye, that no poet in his metre has any right to depart from the usage of the spoken language, at least to the extent of adopting any device to conceal bad versification. This editor marks it also in the first line of a *Bard's Epitaph*—

"Is there a whim-inspirèd fool,"

where in Kilmarnock edition it stood, under a false analogy, as *'d.* Nor was this changed in edition '87. The poet's ear, like Shakespeare's in similar cases, would naturally treat *inspired* as a trisyllable under the influence of the strongly trilled *r*. It is only the very modern Englishman who is doing his best to eliminate this letter. Otherwise Burns has few halting lines. The Irvine MS. of *Mailie* has "O may they never (learn) the gaets," while both MSS. and early editions have *noble* in "An honest man's the noblest work of God." In *The Vision*, Kilmarnock edition has "The lee-lang day had tir'd me," another seemingly faulty line, also due to the trilled letter.

A curious modification of the participial termination marks all the MSS. in contrast to type-forms. This is in *blastiet, tautiet, dautiet, tapietless*, which all appear in type as simply *-tet, -tit*, or oftener *-ted.* Burns seems to have regarded these as formed from adjectives, which, according to his general practice, he terminated in *-ie.* He himself uses *blastie*, and there is a *dautie* and a *taupie.* If Burns got *tapietless* from this last, he made a great mistake. The Kilmarnock glossary edition glosses his word *unthinking.** In earlier days he preferred *-y* for adjectival endings, which was 18th century English, and Ramsay's form also. But in Irvine MSS. there is the influence of an antiquarian fit in the office, and most of the press corrections are devoted to the conversion of his *ony, mony, bony, crony*, to the *-ie* ending. A very few have escaped.

* Cowper professes, in a letter, to understand what the poet meant by calling his muse "a tapietless, ramfeezled hizzie." I question if even Burns had a right grip of this word, still perfectly familiar to a Fifeshire man as *taebetless.*

His practice, however, is here not at all consistent. Proper names have, by preference, *-y*, but in *Tam o' Shanter*, within a few lines, we have *Maggie* both ways. We may find *Davie*, but not *Maily* or *Jennie*. Ramsay is equally uncertain. Fergusson's printer has *bonny lambies, grannie, fou vogie, wow but I'm cadgie.* Burns seems to keep in MSS. to *-ie* in nouns, as *whiskie, pennie, dudie, bodies, dadie.* Connected with this termination is the other practice of doubling the preceding consonant or not, apparently as indicating pronunciation. A second *d* is inserted as an afterthought in Irvine *Jolly Beggars*, apparently in keeping with a thinning and sharpening of the preceding vowels (for example, *duddie, boddies*), while the same result is aimed at in doubling *n*, giving, therefore, distinct sounds of *bonie* and *bonnie, dudie, duddie, bodie* and *boddie, dadie* and *daddie.* The open vowel is certainly the older and truer form. We have now got to be so fond of the shut vowel as to say, *Robby* and *mĕ Lod Prúvost.*

An interesting old idiom appears in the omission of the relative in the nominative case. It is not obtrusive in earlier Scotch, but decidedly so with the 18th century artificial balladists. Hamilton's "Blind Harry" quite overdoes the practice, for example, "Give me that knife under thy girdle hings." What must have facilitated the disappearance of the relative here was the popular form of the relative *'at*, due to elision of the troublesome aspirated dental, "Aa baid a lang while but ther was naebody ['at] cam." This relative in *'at* is abundant in Barbour. A tendency sprang up during the 16th century, under Renascence influence, to use the true interrogative *who* as relative, either in the form *wha* or *quha.* But the true form *'at* has never dropped out of popular speech. It must have seemed to Burns beneath the dignity of literature. Some of his lines, however, would look less irregular or obscure if it were taken into account. A case in point is in the Kilmarnock edition of *Lapraik*:—

> "I've scarce heard ought ('at) describ'd sae weel,
> What gen'rous, manly bosoms feel."

The Commonplace Book MSS. has the unsatisfactory *pleas'd.* Scott Douglas gives this as a variation without note or comment. Another case is in *Tam o' Shanter*—

> "Or like the snow, falls on the river."

Scott Douglas has—

> "Or like the snow falls in the river,
> A moment white—then melts forever."

He adds the grammatical note—"In author's edition, and in all

the MSS., the substantive *snow* stands quite apart from and governs the verb *falls*. Between these words there is an understood ellipse of the relative *that* or *which*. Chambers prints in a way that is pleasing enough—

> 'Or like the snowfall in the river,'

but we suspect that Burns would have preferred snowflake to snowfall had he intended this mode of expression," Mr. Henley is here gratuitously sarcastic over Scott Douglas's presuming to know what the poet would have preferred to say if he had only known how to say it. Chambers coolly drops the *s* in *snowfalls*, simply because *melts* follows, while *his* emendation equally recognises an omitted relative. The Kilmarnock MSS. has a comma after snow, which, if the poet's, precludes the compound snowfalls. There is no getting over the explanation which Scott Douglas gives, namely, that there is an omitted relative. Possibly the popular relative, supplemented by the trilled letter, is accountable for the limping line in *Dainty Davie* :—

> "I flee to her arms ('at) I loe best,"

which Scott Douglas prints as Thomson edited it—

> "I flee to her arms I loe the best."

A reference to the old relative *'at* leads Dr. Murray to condemn *Scots wha hae* as fancy Scots. Barbour would have said *Scottis at hes*, Dunbar *quhilkis hes*, Charteris (end of 16th century) *quha hes*. Burns generally prefers *hae* to the more idiomatic *hes*. By his day *who* had so usurped the functions of the relative in literary speech that its appearance in *Scots wha hae* seemed legitimate. In his prose he, with less reason, sometimes uses *who* in places where *that* would be better English.

Burns found the vernacular pronoun in the first person too great a departure from the conventional to adopt it. When unemphatic, it is simply a very light *a*, for which Burns always writes *I*. In common with Shakespeare and the vernacular, he often regards the pronoun as a quasi-proper noun. Thus he writes, "Like you and I." And again, "Her that is to be my love come after me and maw thee;" "Him at Agincourt few better were or braver." In the same way Barrie has caught from popular speech both this and the relative in *'at*—"The lad Wilkie; him 'at's mither marriet on Sam'l Duthie's wife's brither." "The dog 'at yts leg wuz run owre" is a good example of this relative in the possessive, and peculiarly Scotch.

In demonstratives Burns has nothing of the quite idiomatic *thon*, but uses *thir* and *thae*, the northern plurals of *this* and *that*—

"Thae curst horse-leeches o' the Excise;"

and

"In thae auld times they thought the moon,
Just like a sark or pair o' shoon,
Woor by degrees, till her last roon,
Gaed past their viewin,
An' shortly after she was dune
They gat a new ane."

Again he has—

"Thir breeks o' mine, my only pair."

Generally, however, he uses the quite unidiomatic *these* and *those*, for example,

"And when those legs to guid, warm kail,
Wi' welcome canna bear me."

His indefinite article is *a* or *ae*, never the fancy Scots *ane* in "ane king." Needless to say he never has anything like "ye aulde boke shop."

The only inflection of the noun—the plural—presents some peculiarities. He keeps the Northern *ky*, *een*, *horse*, and the like—

"Altho my bed were in yon muir
And horse and servants waiting ready."

But, in addition, he cannot escape the peculiarly national partiality for the plural point of view. The Scot likes to say "friens wi' you," "murnins." Burns has no occasion to treat "the healsome porritch" as a plural, the vernacular usage, but in *Halloween* his footnote has "Sowens with butter, instead of milk, to *them* is always the Halloween supper." It is not the *s* that deceives here, for *bellows* has in the plural *bellows-es*. Currie shows curiously his own Scotticismus (to adapt a German expression) in correcting the prose of the second Commonplace Book. Burns wrote *acquaintances*, but Currie, thinking Burns here guilty of a Scottish idiom actually made it into one by correcting to *acquaintance*, which in Scotch is treated as a plural. [It is well to interpret it so even in "Should auld acquaintance be forgot?"] This is nothing to the *faux-pas* of Scott Douglas, however. In *Lapraik* Burns wrote in the first Commonplace Book—

"But by your *leaves*, my learned foes,
Ye're may be wrang,"

which is characteristically Scotch. His editor, however, corrects and explains—"At close of verse 10th the expression 'by your

leave' in all the author's editions, inadvertently reads 'by your leaves.' The *plural of leaf* is not the poet's intention here." This is certainly wonderful *näiveté* in a critic. It is worth noticing that both the author's editions (Kilmarnock and Edinburgh, 1787) have "by your leaves," but the punctuation or arrangement adopted by the editor here disguises the fact.

I have shown that answers *aff loof* are not to be given to the queries I have raised. Yet the evidence adduced points to definite enough conclusions. Close scrutiny of the MSS. has been to me a revelation, though I had thought I knew my Burns fairly well. It has shown me how near we were to losing him as a master of the vernacular and poet of the national life and feeling, and how often his English models led him away from the genuine dialect. Much more on the same lines as the foregoing, directed to the poet's versification generally, and to his characteristic diction in its meaning as well as form—untrodden ground—would give a more favourable answer to the question—Was his ear familiar with the spoken dialect? Still other queries arise. Does textual criticism help us to determine the comparative value of various readings, to restore the rejected and modify the accepted, to lighten up the obscure and emphasise the clear? No wonder the editors have hesitated to tackle such a formidable task. Must we wait till the *variorum* Burns, like the Shakespeare, come to us from America, and another Irish professor, like Professor Dowden, give adequate treatment to the Mind and Art of Burns?

NOTE.—On p. 24, in the discussion of a various reading (*Tam o' Shanter*), the reference is to the old edition of *Chambers*. The last edition (4 vols., 1897) is substantially a new work, edited in a thorough and scholarly fashion by Mr. William Wallace. In the passage under discussion he has restored the original reading,—

"Or like the snow falls in the river,"

and recognised the omission of the relative.

VI.—*Some Aspects of Political Economy from a Commercial Point of View.* By George Handasyde Dick, President of the Economic Science Section.

[President's Address—read to the Society, 24th February, 1897.]

I am honoured by being appointed to the Presidency of the Economic Science Section of the Philosophical Society of Glasgow, successor in the office to Professor Smart. This is our first meeting as a Section since the establishment and endowment of the Adam Smith Chair of Political Economy in Glasgow University. It would be violence to our appreciation of the wise munificence of Mr. Andrew Stewart, who has amply endowed that Chair from his private fortune, did we not express our sense of the public service which Mr. Stewart has thus rendered to the revival and permanent maintenance of the teaching of political economy at the historical seat of its foundation. It must be further satisfaction to all that the first incumbent of the Adam Smith Chair is a gentleman who has a wide reputation as an economist, a special gift of teaching, and a mercantile experience giving added value to that teaching.

Thanking you for the honour you have conferred upon me, I would add that no one feels so much as the present incumbent how limited is his fitness for the office of your President. Following use and wont, it now falls to me to submit the inaugural paper of the session.

It is of the nature of inaugural addresses to consider broad aspects of the subjects of study rather than any special thesis with its details. I avail myself of the liberty granted by this characteristic to submit for your consideration some points which are of great importance to my mind, and, I have reason to know, to other minds also. I seek to ventilate these points, not as an economist, but rather as a merchant, who has little more special qualification for dealing with them than is furnished by the

"remainder biscuit" of a somewhat lengthened and varied commercial experience, in which economics have demanded consideration in the commercial more than the strictly scientific aspect, and that mainly in connection with foreign exchanges.

Political economy is doubtless more largely, if not more wisely, regarded by the commercial community than by any other class equally influential and important. If this paper enables what may be called commercial economists to gain more exact or wider knowledge from their more scientific brethren, a good purpose will have been served.

By the courteous usage of the Philosophical Society, discussion upon presidential papers is not permitted except by request of the President. Gentlemen, I invite you to discuss this paper fully, in the hope that such discussion will eliminate any error and strengthen any truth it contains.

As my paper is intended to be somewhat discursive, the title chosen for it necessarily reflects that feature. The title adopted is "Some Aspects of Political Economy from a Commercial Point of View."

Before entering upon other matters, I wish to say something regarding the attitude of mind with which students of economics must approach their subject, the spirit in which the study of the science must be carried on, and its discussions be maintained. Past experience and some current writing appear to call for this preliminary digression.

There is probably no one to dispute the trite axiom that all scientific study must be approached with humility of mind; without bias or prejudice, and with the single object to ascertain and hold to whatever is capable of proof—regarding what is unproved as only speculative, and therefore subject of inquiry. But as this state of mind is not commonly given to humanity, it becomes essential, carefully and constantly, to distinguish between scientific realisations and what are but impressions of the mind.

Probably, too, it is a fact, though too difficult of proof to be called a scientific law, that the overwhelming mass of individual opinion is that one's own opinion is the best. It is not suggested that this opinion is commonly expressed, it is only suggested that it is commonly held. Manifestly the mental attitude must be thus, because so soon as a better opinion is brought before the unbiassed mind with sufficient clearness, the mind must receive it. Therefore, as few plead guilty to mental bias, the individual

commonly holds the best that he knows is the best that can be known. The less mankind is instructed, the less it knows of the innumerable possibilities of error, and, resultingly, the more dogmatic it becomes. Hence the common attitude, which may be indicated as—"I cannot traverse your arguments as you do mine, because you have studied the subject more and know the facts better, but still I think you are wrong." This attitude of opinion, in opposition to reason, is common when an individual is brought face to face with truth that is hitherto unrecognised.

Every true student of economics will be ashamed of even the most innocent errors of statement, will be careful to avoid them, and be without mental rest until he does all in his power to correct them, if inadvertently they do arise. He will be most careful fully and fairly to understand, and give special weight to, views opposing his own, and to resist taking advantage of any manifest error in another's mode of statement. He will avoid discussion for polemical advantage, and will be alike eager to acquire and to impart economic truth. The use of any language that imputes motives other than the highest the arguments permit, or the use of any language that implies personalities, alike place the user out of court and close discussion with him. Fortunately this is the unwritten law and practice. When unable to refute argument by reason, the temptation to conceal that inability becomes powerful. Some minds are prone to value the importance of their individual intellectual attitude by its importance to their self-satisfaction. Such self-satisfaction is but an unworthy substitute for "the joy of one who loves but knows not" on learning from "one who loves and knows."

Recent public writing dealing with economic questions has sometimes been disfigured, when not rendered injurious, by imputations and personalities. Bad as it has been in this country, it has been as nothing compared with what has largely obtained in America. The clergy there, as in this country, have recently taken somewhat prominent, if unsolicited, part in discussing questions of political and economic import. As advocates by profession of peace and goodwill among men, their utterances should deserve to be regarded as not inflamed by the rancour of the less charitably disposed. Here are some illustrations of their statements with regard to the recent Election in America, taken from the columns of the *New-York Herald.* The Rev. Thomas Dixon stated—"At one time silver was at two

cents premium, and the mine owners would not bring it to the mint. For the sake of these two cents premium these patriots were willing to let the country go to hell. Bryan is a demagogue. He makes me ill, this slobbering demagogue." The Rev. Mr. Myers said—"You have objected to my saying the Chicago platform was made in hell—what do you say now that you smell the sulphur?"

These quotations, taken from similar utterances of a number of American clergymen, are alike the warning to those who mistake abuse for argument and the justification for declining all reply. Leaving this preliminary digression, I proceed to consider first—

DEFINITIONS OF POLITICAL ECONOMY.

There is probably no more common outstanding impression among fairly informed men than that the science called political economy is dry, dull, uninteresting, without appeal to any higher or better human thought or motive than sordid material gain —that political economy is but the recognition of that spirit of self-aggrandisement, which, undoubtedly, is an existing trait in humanity, but of the earth earthy, and seeking to give effect to that characteristic, so that it may have the largest possible measure of fulfilment. For this common opinion some economists themselves are perhaps more answerable than many outside the pale.

It is useful and interesting to inquire what is the cause of a popular impression so universal, so regrettable, and yet, it is submitted, so ill-founded—being, in fact, opposed to the teaching of recognised economic authority.

This inquiry takes us back to some prosaic facts, which, from their commonness, are generally overlooked or are but slightly considered. The foundation of the name of our science is the Greek word *Economy*, having for its roots, *oikos*, a house, and *nomos*, law; and for its meaning, the laws of household management. When adopted, doubtless the name conveyed what was generally understood thereby, and expressed what was then regarded as the limit of the science. With the advance of knowledge, however, it became apparent that the principles applicable to household management (the house or family being a unit of government under Roman Law as formulated by Justinian) were also applicable to larger communities, such as conquered provinces and subsidiary States; again to larger aggregations of men, such as nations; and, finally, to the world at

large. Therefore the name of our science had the word "Political" (pertaining to *polity* or government) prefixed to *Economy* to distinguish it in this enlarged understanding. Having thus arrived at its name, embodying the recognised vastness of its field of study, it has since been almost a passion with some learned men to define what is to be understood by that name—what the name includes and what it excludes. Had this been done in a spirit recognising the scope of economic study, which the amendment of the name makes clear, objection need not have been taken. The reverse of that, however, has been generally the fact. Thus we are told, in varying forms of words, but as final definitions, that political economy is "the science which treats of the production, distribution, and consumption of wealth." Such would-be definitions are numerous and various, and are mostly true so far as they go, but all fail in even indicating the whole scope of political economy.

Again, we have negative definitions — statements of what political economy is not. Thus we are told it does not embrace any observance of religion, or the communication of instruction, and is wholly divorced and separate from ethics (defined as the science of duty) as from morals (defined as the good conduct of men in the doctrine and practice of the duties of life). Some would even divorce political economy from the sphere of politics, with which it seems safe to say it is co-ordinate.

These definitions, whether positive or negative, are alike the findings of economists, and it is submitted that through these miscalled definitions, which after all are so inadequate as to be at best but characteristics, our science has been "injured in the house of its friends." It is predicted that any science so vast in its diversity, and so surrounded by qualifying considerations, cannot be exhaustively defined at any time; and further, that even were such definition possible at one time, it would, with the growth of knowledge, speedily become too narrow, and therefore incomplete. Marshall well says—"Economic conditions are constantly changing."

Such conceptions of the limitations of political economy suggest to the mind, as a corollary, a system of astronomy which would forbid the consideration of the law of gravity or the existence of a First Cause.

From such narrow and chilling conceptions, it is as a change from arctic winter to midsummer sunshine to revert to earlier and

more authoritative statements. Thus we find Dugald Stewart describing Adam Smith's "Wealth of Nations" as "the most methodical, comprehensive, and judicious digest of all the most profound and enlightened philosophy of the age." Mark *all* philosophy. In Adam Smith's great text-book itself we find that the subjects treated range from religion and the Reformation to cock-fighting.

Again, John Stuart Mill, in his "Principles of Political Economy," says—"In the economical condition of nations, in so far as the causes are moral or psychological, dependent on institutions and social relations, or on the principles of human nature, their investigation belongs not to physical, but to moral and social science, and is the object of what is called political economy."

Mill does not give this as a final definition of political economy. It is, however, his statement that political economy includes moral and social science—lines of ethical inquiry from which recent definitions would debar it altogether. Marshall says—"Political economy . . . is on the one side a study of wealth, and on the other, and more important side, a part of the study of man;" and in another place he states—"Ethical forces are among those of which the economist has to take account. . . . There seems to be no good reason for excluding all altruistic motives, the action of which is so far uniform in any class at any time and place that it can be reduced to general rule." Hear what the honoured French economist Bastiat says on this point:—

"Let us take, by way of illustration, a man in the humble walks of life—a village carpenter, for instance,—and observe the various services which he renders to society and receives from it, we shall not fail to be struck with the enormous disproportion between them. This man employs his day's labour in planing boards and making tables and chests of drawers. What does he receive from society in exchange for his work?

"First of all, on getting up in the morning, he dresses himself, but he has himself made none of his clothing. In order to put at his disposal this clothing, simple as it is, an enormous amount of labour and many ingenious inventions must have been employed. Americans must have produced cotton, Indians indigo, Englishmen wool and flax, Brazilians hides, and all these materials must have been transported to various towns, where they have been worked up, spun, woven, dyed, &c.

"He sends his son to school, and the simple teaching which is given there is itself due to the work of many thousand minds.

"If he undertakes a journey, he finds that, in order to save him time and exertion, other men have removed and levelled up the soil, filled up valleys, hewed down mountains, united the banks of rivers, and brought the power of steam into subjection to human wants. It is impossible not to be struck with the measureless disproportion which exists between the enjoyments which this man derives from society and what he could obtain by his own unassisted exertions. The social mechanism then must be very ingenious and very powerful since it leads to this singular result, that each man, even he whose lot is cast in the humblest condition, obtains things every day which he could not himself produce in many ages.

"The study of that mechanism is the business of political economy."

Even this beautiful illustration, far-reaching as it is, but indicates one division of the vast science of political economy. It is submitted that in the branch of philosophy which is our special study, clear lines of demarcation between political economy and ethics, or between economics and morals, cannot be drawn, because, in parts, they not only shade into one another, but are interwoven warp and woof. Further, that the effort to set up clear distinction and divorce between their spheres is injurious, and not advantageous alike to economics and co-related science.

To illustrate: A sermon was recently preached by a gifted thinker, who took for his text the commandment, "Honour thy father and thy mother that thy days may be long in the land which the Lord thy God giveth thee." Surely this command is of the moral law, but the arguments adduced in proof of its scientific truth—the sermon, in fact—could be found in the writings of Bastiat. So apparent and close was the parallel that the preacher was questioned as to whether or not he had derived his arguments from Bastiat, and he answered he did not even know Bastiat's name. Taking this fact as illustrative, it is asked—How could economics be defined as having nothing to do with morals? The truth is that the deduction was as true and forcible from economic science as given in Bastiat, as from moral science given in the sermon. Thus the effort advantageously to discriminate and classify one conception as two sciences—the one as ethical, the other as divorced from ethics—must fail. Unfortunately, however,

such discussion has doubtless been largely the reason for our study being branded as dry and barren of the highest good; at best, the science of selfishness; having practically neither foundation nor superstructure in the higher affairs of mankind, because divorced alike from ethics and morals by being wedded to that lower instinct, the selfish acquirement of material gain.

The illustration, if viewed from moral law, is honour thy father and mother, because it is moral to do so; and adds that, in the circumstances stated, the reward of "long life in the land" will follow. In the economic view the aspect is long life with a long lease of land rent free in exchange for honouring one's parents. Long life and free possession of land are doubtless of considerable money value, yet here they appear to be put in balance against what may be but an attitude of mind towards parents. This illustrates the vast complexities in the meaning of the word value. That word lies at the root of common definitions of economics, and, since the days of Ricardo and Malthus, has been an unending subject of dispute, which cannot be entered upon here.

A respected authority writes—"Science is the observation and analysis of observed uniformity; and the science of political economy has its root in value, which is quite distinct from politics or ethics, or anything else."

I most respectfully dissent from that as a full statement of the whole truth. I find it to be of interest, however, as probably furnishing explanation of the divergence of definition between earlier and some of the more recent economists.

The exigencies of recent scientific thought crave for unquestioned accuracy of definition. Such accuracy of definition being impossible of application to so vast a study as political economy, some of its professors have, in recent years, abandoned the plain and logical meaning of its title, and, choosing a portion of what is included in that title, and which is capable of more or less exact definition, have treated it as if it were the whole of political economy, when it is but a part.

Again, to quote Marshall—"Nature's action is complex, and nothing is gained in the long run by pretending it is simple, and trying to describe it in a series of elementary propositions." The effort after definition and limitation in matters which are continually the subject of moral or intellectual growth, and are manifestly too vast for definition, is probably a legacy left us by the churchmen and from the schools. In earlier times it was a

common attitude of mind, especially amongst theologians imbued with the Hebraic Scriptures, that the sum of human knowledge had been reached and was known; therefore all that remained was to define this knowledge, and conform all men to it. Under that belief the study of astronomy was arrested for centuries, and many of its precious records were destroyed. Since then we have learned much of what now appears to be the almost illimitable possibilities of human intellectual acquirement. Consequently, we are in all directions bearing down limitations that would cabin and confine human thought when striving after knowledge and understanding of truth. This battle for scientific freedom has raged for years, with the result of a continual increase in intellectual liberty. The fight is likely to go on until all true thought becomes enfranchised—its acceptance dependent upon logic and upon facts, not upon the unsupported dicta of authority, however ancient or assertive. After all, it is knowledge and truth mankind is grasping after with a divine yearning; and theologians, historians, scientists, and schoolmen are only valuable so far as they subserve that inquiry.

It is submitted that political economy might fairly be characterised, not defined, as the study and scientific definition of all that relates to the regulation and material advancement of mankind, individually and collectively; its science as that which relates to the discovery and formulation of its laws; and its art as that which appertains to the practical application of these laws to the use and advantage of mankind.

"Economics" might, without clashing with that description of political economy, be defined as "the observation and analysis of observed uniformity which has its root in value." Economics would thus become a division of what is included in the vast study known as political economy—a science that has become so divided and subdivided by specialists that its grandeur and use are in danger of being underestimated or forgotten.

In answer to the foregoing statement of the characteristics of political economy, it may be urged that it is not a definition, is not exact, and therefore is unscientific. A natural reply is that, while many of the maxims of political economy were previously known, it has only been recognised as a science for little more than a century. Even now its laws are but in process of formulation; such as are known are not always accepted as beyond question. Until they are generally accepted as axiomatic, a common

meaning of the word science (applicable say to mathematics as verified and systematised) is inapplicable in the instance of political economy as a whole. The application of the word science to political economy *as a whole* must, therefore, be in large part that other meaning of the word, indicating superior, but not final, complete, or unquestioned knowledge—rather, indeed, as system opposed to random, and verification as opposed to assumption. The time when political economy can be called an exact science is manifestly very remote, even if the constant changes of environment ever permit it to come at all, and doubts on that point are surely permissible.

Is the conception of political economy that I have suggested a true conception? Does it make call upon the best of men in their best hours, or is it "the dismal science," without hope or sympathy beyond what is conveyed by some current definitions?

If what has been urged is accepted, it will be possible to carry research after economic law into regions of thought which some would-be definers make forbidden ground, and to find response to economic theory advanced to legitimate conclusions, albeit these conclusions may be claimed by other sciences also.

"All roads lead to Rome," and, provided we get to scientific truth, it should be matter of satisfaction, and not the reverse, if it can be reached through political economy untramelled by unwise definition, and also through kindred science. With the abrogation of impracticable barriers of definition, the recent remarkable increase of zeal with which the study of political economy is being pursued, in England as well as in Scotland, will have room to grow and expand. Then the study will not be limited to the consideration of what affects the production, distribution, and consumption of wealth alone; but, going beyond and higher than this mundane conception, will, under its science, be not only entitled, but be bound, to consider what affects the well-being of mankind, as individuals and as associated. Bastiat says—"The well-being of the individual favours the well-being of all; the well-being of all favours the well-being of the individual, creating harmony, and not antagonisms." This, it is contended, indicates the scope for our study which is essential and inherent.

On the other hand, it has to be pointed out that individual truths of political economy are capable of scientific definition, and that their definition is a primary object of our science. Such definitions, however, are widely different from futile

effort comprehensively to define the whole science of political economy.

On the broad conception of political economy which has been submitted for your consideration, new aspects of old questions and enlarged views of the sphere of political economic work and influence arise. By it commanding appeals are made to the higher motives as well as to the higher intelligence of mankind. In its science the foremost intellects can find work and intellectual reward, also common ground of agreement for widely-varying gifts and capacities.

Gentlemen, the generalisation with which I have sought to deal with this point gives rise to consideration as to whether or not such mode of treatment may not fail—quoting Lord Bacon's words, "to bring home to men's business and bosoms" what is contended for. This consideration renders a little detail advisable. Let us, therefore, consider the first negative statement as to political economy given at the beginning of this paper, namely, "It does not embrace any observance of religion." That economics do not embrace the observance of religion by the disciples of economics, as such, is, of course, true, but it is equally true that political economy does, and must, concern itself with the observation of the effect of religious beliefs on communities of men. Thus it cannot surely be disputed that it is the office of the political economist to ascertain whether the recent expulsion of the Jews from Russia was due to their religious beliefs, or to their business or social practices. Again, we have the more recent instance of what is called the Armenian Atrocities. To what are these due? In this country it is all but universally answered—to the fanatical religious animosity of Mahomedanism. But economists must doubt this, and decline to accept it until it is proved. Armenians are the money-lenders of Turkey, and their business dexterity is historical. It requires only a very moderate acquaintance with the measure of attachment of some Eastern as well as Western peoples to their faith, in comparison with their attachment to their money, to conclude that possibly the recent enormous fall in prices in Turkey, resulting in the disturbance of previously existing relations between debtor and creditor, may furnish a more tangible and intelligent explanation of recent deplorable events in Turkey than the difference between a qualified Christianity and Mahomedanism. Speaking on the authority of respected Armenian friends, with whom I have done business in Constantinople for a good many years,

I have to say that there is no more honest or upright people in the world than the Turks. They look upon failure to discharge their debts as a lasting disgrace. Consider what must be their feelings towards creditors whom, owing to an entirely novel monetary position, they cannot satisfy. Consider, again, the feelings of the Armenian money-lenders towards debtors who are unable to pay their legal debts, and remember that neither side has ever learnt the fundamental law of money, that "its value depends upon its quantity and not upon its quality." Turkey is a gold-standard country, owing foreign gold debts, but not creditor of any country. Therefore her national position is injured by every appreciation of gold, and every monetary transaction of her people is qualified by the appreciation of her standard of value—the debtors are impoverished and the creditors (when they get payment at all) are enriched. It is also useful to remember that usury (interest) is forbidden by the laws of Mahomedanism, but not by the laws of Armenian Christianity. There are interesting stories in the East as to fabulous fortunes acquired by Armenians, &c., through trading upon the religious objections of Mussulmen to receive interest on their money. The subject of usury in this country now only occasionally crops up in money-lending cases before our courts. It was, however, most earnestly debated in many treatises and in many sermons during the seventeenth and eighteenth centuries.

Until the true cause or causes are ascertained of Turkish and other national horrors, the fundamental cure of such evils is unlikely. The discovery and formulation of these causes make claim upon the political economist. These illustrations surely show that political economy must embrace the study and observance of the effects of the religion of Jews and Mussulmen as well as of professed Christians. Any economic conception of mankind without religion would be an absurdity, because contrary to universal existing fact; but it is not part of the economist's duty to desiderate between the many forms of religion, except in so far as such observances appear to make for the general well-being. Economists must recognise the Christ of the Christian, the unfathomable, almost unpronounceable, Ja Ho Yah of the Hebrew, the Unknown God of the Greek, as well as what are believed by large communities of men to have been, or to be, other embodiments of a Universal Almighty First Cause.

Turning from that aspect of political economy, I ask your attention to

The Present Economic Position in India.

The civilised world is at present deeply concerned with what is called "The Famine" that is threatening eighty millions of our fellow-subjects in India. Probably never before in the world's modern history has there been any question making more emphatic call upon economists for light and leading. Popularly the disaster is attributed to the want of usual rains, having, in considerable districts, caused the crops wholly or partially to fail for a season. This is, no doubt, so far true. On the other hand, it is matter of common and universal knowledge in India that the country is subject to such partial failure of crops at uncertain intervals. The present partial failure, after on the whole good seasons for eighteen years, must therefore be looked upon as normal and not abnormal. Recognising this liability to failure of crops, the Government of India, after the last terrible famine in the Mysore District, set itself to provide against loss of life from the same cause in future. Important works having that object were undertaken. I refer here to two—namely, irrigation and railway works. We are reasonably told that irrigation works have been of vast service in mitigating the present calamity. Even more important than these, however, is doubtless the opening of the country in all directions by what are called famine railways, upon which (at par of exchange) some sixteen million pounds have been spent in the past seventeen years.

Now, we have this most remarkable phenomenon, to which I ask your earnest consideration. With a continent said by some persons to be threatened with the most awful calamity of famine which modern times have ever known, it is but rarely suggested, either in Indian or home papers, that there is any actual scarcity of food to feed all the people. The London *Times* of 4th instant publishes a telegram from the Viceroy asking that money be sent in preference to food. Lord George Hamilton, speaking at Harrow on the 10th instant, stated the Viceroy and himself had arrived at the conclusion that "with the spring crops there would be sufficient to carry the people on." We constantly read of higher prices for food, but never that food cannot be abundantly bought at the higher prices. Did the world ever before see such a situation as a famine of money with which to buy food, while

sufficient food existed to feed all the people? The fact is, indications seem to point to the Indian famine as a money famine, not a food famine. That there is a money scarcity is evident from the fact that, even in these times, when famine and plague and monetary uncertainty have enormously curtailed the business of India, the rate of interest in the Indian bazaars is not quoted under 16 per cent., and even at that usurious rate money can hardly be borrowed. The minimum lending rate of the Bank of Bombay is to-day 12 per cent., but its funds are so contracted that it is refusing loans on Government paper. Under these circumstances, and with discount in London under 2 per cent., money would at once and naturally flow to India, were it not that the rate of exchange at which it could be brought back again is so uncertain that even a difference of 10 per cent. in the rate of discount is recognised as insufficient to cover the risk incurred. That the "scarcity rupee" has led to its exchange value being now 20 per cent. higher than its melting value is known to us all. But the question arises—How much is this scarcity of rupees, which is maintaining exchanges, responsible for the phenomenal money scarcity now existing in India? The highest price I have observed quoted for rice in India has been eight seers for the rupee, but, according to the district, the rates vary, say, between nine and fifteen seers for the rupee. Take the average as, say, eleven seers, and let us put that into more familiar terms. A seer is 2·204 lbs. in our weight, and eleven seers make therefore 24·244 lbs., say 24¼ lbs. A rupee at present exchange is 1s. 3d. of English money. Now what evolves? 1s. 3d. of our money buys 24¼ lbs. of rice. We have eighty millions of people suffering from scarcity inimical to health, or from scarcity threatening death, when food is apparently abundant enough to feed all, at a price of, say, ·68 of a penny per lb. The present price of wheat in Glasgow is 16s. per 240 lbs. = ·80 of a penny per lb.

Gentlemen, has it ever occurred to your minds to conceive of poverty such as the foregoing indicates? Here we have probably the most industrious, the most economical, the most peaceable, and well-regulated people in the world face to face with death from starvation, because they have not money sufficient to buy food grain, which can be purchased in the worst case at under a penny per lb. Remember, too, that beyond their food requirements their wants are of the fewest, as neither clothing nor houses are essential in immense districts of that country.

It would not be reasonable to suppose that this poverty of the Indian people, and their consequent reduction to starvation point, is due alone, or mainly, to the partial failure of one season's rains in a country frequently producing two, sometimes three, crops in the year. It may be mainly due to economic causes. Such causes have long been foreseen and pointed out by many economists and by the viceroys and finance ministers of India. Notably has this been done in the remarkable despatch of the Government of India, signed by the Viceroy (Earl Dufferin) and his Council, of date 2nd February, 1886. It is too lengthy a document to quote here, and too important to summarise. A copy of it has been placed on your library table, where reference to it can be had. Such reference casts a flood of light upon the causes of the deplorable position of India to-day. Read in light of later events, it goes to show that existing troubles in India are mainly due to economic causes for which the people and Government of Great Britain are mainly responsible. The First Lord of our Treasury has been at pains to point out that in this matter the moneyed interests here are permitted to rule the councils of this nation. Probably the permission is used in their own supposed interests, certainly it has been used in direct opposition to the policy of the Government of India. But the trouble does not appear to end here. It is alleged by other nations that, through the British Government, the councils of the civilised world are nullified and made of none effect. If so, it appears a blunder or a crime so vast that the growth of economic knowledge can alone make its terrible proportions fully plain. Meantime the ordinary mind revolts from contemplating the possibility of so vast an error having been committed without the general cognisance of mankind, when it was so well known and has been so long anticipated by the most competent authorities.

If the despatch mentioned is correctly regarded to-day as a monument of far-seeing wisdom and statemanship—its truth demonstrated by experience,—consider in connection with it that this country is now fussily engaged, with much unction to itself, in sending an insignificant charity dole of under a crore of rupees to the Government of India, which Government has for years past been compelled, by the alteration of laws in Europe and America, to send annually to this country Indian produce valued at 8 crores of rupees (at par of exchange £8,000,000) in excess of what the interest it has to pay was reckoned at when the debt was

mainly incurred. It is asked—Are we thus in our relation to India, as rulers, reviving ancient barbarisms by living in luxury while drawing upon the labours of the subject races of India till these races are impoverished below subsistence point? We can all see, that were it allowed to do so, the Indian Government could relieve the present money stringency by the coinage of sufficient rupees for Indian requirements. On the other hand, it would seem equally plain that such additional coinage would cause the existing rate of exchange to decline materially, and so accentuate accordingly the burden of India's gold indebtedness abroad. The famine appears to prove that indebtedness to be already unbearable. These are submitted as two horns of that dilemma for which the deaths from starvation in India make clamorous demands for speedy solution.

The importance of the Indian famine has led me to larger statement regarding it than I at first intended. I close it expressing the heartfelt prayer (I am sure of all of us) that the holocaust of death of Her Majesty's Indian subjects will not now, as is feared by some, prove greater than in the Mysore famine, when nearly 6,000,000 people were starved to death. Such a record of preventable death would create a record and memorial of the 60th year of the Queen's reign horrible to contemplate; and all the more terrible if it has arisen in despite of the arguments and warnings during many years of those best able to judge and guide. It is a satisfaction, if a poor one, to this economic section, that every prominent economist has held clear arguments and reasons with regard to this awful matter. A pity and pain it is that perhaps "the narrowing lust of gold" has not only rendered many hostile to the teachings of economists, but has led them to ridicule, malign, and misname those whose arguments, it is only charitable to suppose, they did not understand.

THE ECONOMIC SITUATION IN THE UNITED STATES.

Another prominent aspect of political economy, from a commercial point of view, is the position in America. The election of Mr. M'Kinley, we were assured by the leading paper in this country, and by the bulk of the press both in America and this country, was to result in a great commercial "boom" there. What are the facts? America has been favoured by a large advance in the value of her wheat, an advance in the price of her cotton, and abundant crops. Yet between December 3rd and

January 4th last, no fewer than 29 American banks failed, three more railways went into receivers' hands, and the quasi-starving population of Chicago out of work is stated to be 50,000 persons, while there is great distress in New York and other centres. This is but another instance of failure to grasp and understand economic law. No explanation or regret over such blundering is expressed. More remarkable still, many men continue to read and quote as deserving of weight commercial articles, even when the statements of these articles have been condemned in anticipation by practically all economic authorities, by the leading statesmen of Europe, and by all the statesmen of America, by the majority of the gold and silver commission in unmistakable terms, by its minority in more cautious terms, by the unanimous vote of the House of Commons, by the Governments of most civilised nations, and by events everywhere.

Necessity for Teaching Political Economy.

Unless this paper has already wearied you, I wish to ask your notice to grave necessities for economic teaching, and to direct your attention to the increasing force and power exercised by the science.

While it is true, in a measure and in a sense, that the world is ruled by kings and statesmen, it is equally true that the domestic governmental concerns of this and other principal nations of the globe are, under democracy, largely influenced by the people. Even their foreign affairs are becoming each year more dominated by the public. Again, employers have now to face associated bodies of their workmen, and workmen have sometimes to face associated bodies of employers. Either individual employers or individual employés must therefore find themselves unable, even if they were desirous, to dictate arbitrarily rates of wages or conditions of work. This nation's trade and industry, therefore, largely rest upon employers and employed, as a whole, working harmoniously together for the advancement of their common interests. To secure that harmony mutual intelligence is essential.

With the last extension of the franchise in this country, Lord Sherbrooke stated that it was necessary for us to "educate our masters." The truth of the statement had universal acceptance. In 1870 for England, and 1872 for Scotland, Acts of Parliament were passed providing for the compulsory teaching of "the three R's." as it is called. Further, but generally inadequate, provision

has since been made for secondary schools and for technical instruction. But, strange to say, no provision has been made by Government for teaching that science which is in the closest relation to the system and art of all government. In recent years steps have been taken by universities, societies, and individuals to make some, though utterly inadequate, provision for the advancement of economic knowledge among the higher classes. Other institutions, such as St. Mungo's College and the Athenæum of Glasgow, have made, and are making, such efforts as their circumstances permit for the economic education of "plain people;" but their efforts, in comparison with the work to be done, and the importance of the object aimed at, are as a drop of water in the ocean. For many years past now the neglect of the teaching of economics in this country has been nothing short of a national discredit. When comparison is made with the Continent of Europe and the United States, the magnitude of the neglect is emphasised. A curious feature is that, contemplating the illustrious roll of economists, past and present, in this country, it cannot be gainsaid that the failure to teach economics is not due to want of scientists of sufficient culture. We have many such. Partly it may be due to the omission of this subject from university curricula for degrees. If so, that is now becoming a thing of the past. In any case, however, that cause is insufficient to explain the problem. The true explanation is probably to be found in public apathy, due to want of knowledge on the part of the public of the importance of the science in all relations of life—its importance politically, and its importance to our industry and commerce. Distinctly more hopeful, if still unimportant, signs are now to be recognised of the growth of knowledge, and with it the growth of interest in political economy, in Scotland.

In recent years the merchants of Edinburgh endowed a Chair of Political Economy in the Edinburgh University, and now proposals are on foot for the establishment of an Economic Society there, to have either a local or a national sphere, as prudence may direct. Glasgow has just had the Adam Smith Chair established and endowed. The Glasgow Athenæum has this year a large and enthusiastic class of students of political economy under the teaching of a talented lecturer trained at our own university. St. Mungo's College is also eager to make progress in the same direction. These facts, if fairly indicated, are hopeful for the future of our science. Distracted as our commerce constantly is

by ruinous and destructive strikes and lock-outs, the public conscience is revolting against such senseless procedure, and is demanding that more reasonable methods of settling disputes be adopted. The most reasonable road to that reasonableness is surely by enlightening employers and employed upon the facts which, whether they see it or not, go to regulate the rates of wages and conditions of employment.

As the political masters (owing to their overwhelming vote when combined), and as the hands and arms, without which our industries and commerce must cease, there is clamant demand upon the Government for the economic education of the people, and clamant demand upon all classes of the community for reasonable help to this education. On this Economic Science Section of the Philosophical Society there is primary demand that it give no uncertain voice on the subject, and that it does all that comes within its sphere to forward the cause of economic teaching for all classes of the community. It cannot be sufficient to educate the middle and upper classes alone. The working classes must also be got at. It is too much to hope that all that is included in so intricate a science as political economy can be mastered by the toilers of any country. But among these toilers there are born leaders, men having high intellectual capacity, who can be educated as fully and sufficiently in a branch of science as the competent of the more-leisured class. There are the higher workers, such as managers, clerks, foremen, &c., all generally holding their posts from their proved intellectual capacity and energy. Such men would value the teaching of economics for its individual mental culture as well as from its direct relation to the every-day business of their lives. They would be invaluable lay helpers, and could perhaps explain points of economic importance to the working classes better than more technically informed teachers. In every industry the working classes generally have that fundamental qualification for understanding questions relating to their own affairs that is denominated common sense. It is to their understanding of economic science in their own affairs, showing all they can expect, and what as workers they can attain to, that their individual contentment and well-being must be looked for—through this the national well-being be advanced.

One curious feature bearing upon economics has already been pointed out, namely, the illustrious roll of its professors in this country in contrast with the limited nature of the teaching.

Another curious feature is that both in England and Scotland there is a number of competent and advanced students of our science so impressed by its potentiality for the common well-being of mankind, and so enamoured of its intellectual satisfaction to their individual minds—loving the study for its own sake,—as to be willing to make sacrifice of their individual material gain could they see modest remuneration, with permanent outlet, for their teaching capacities. As the public comes to recognise all that such teaching means, it is not beyond hope that private liberality will join with the Government in availing of such teaching, and will unite in impressing upon the Government of this country, which has granted and approved of the extended franchise, some measure at least of the scientific education essential for its worthy exercise.

Turning to my last point,

THE INCREASING FORCE AND POWER EXERTED BY POLITICAL ECONOMY,

I would, in a word, ask your consideration of the recent economic upheaval in the United States, due to the currency question in connection with the Presidential Election.

If there is anyone in this country who approves of "free silver," as it is called, for the solution of international currency difficulties, I can only say I have never heard of him. Some would not, however, have been disappointed if Mr. Bryan had carried the day. Not that they desired free silver, but because they saw in it a potent means for compelling attention to the reformation of the currency of the world upon universal and stable lines. However, the point to which I wish to ask your attention in closing my paper is that this economic question of free silver was almost unheard of three months before Mr. Bryan's nomination. When nominated he had neither reliable agents, nor friends, nor funds, with which to canvass so vast a constituency, while his opponent had all these in abundance, and much more besides, which it is perhaps best not to particularise. Yet in so vast a constituency, when the poll was adjusted, it was found something like 20,000 votes out of the 13,000,000 recorded would have carried Mr. Bryan to victory. Never before in history has there been so vast, powerful, and rapid evolution in any economic question. Whether free silver is right or wrong, surely what has been said emphasises with overwhelming urgency the necessity that exists in every

democracy for educating the people in that science which is the special study of this branch of the Philosophical Society, and with some aspects of which it has been the object of this paper to deal, necessarily in broad aspects, in an indicative manner only, and from a commercial-economic standpoint. Let each of us individually ask ourselves if there ever has been a time within our experience when the affairs of the world, political, commercial, and industrial, presented so threatening and chaotic an aspect as the present time, and let us, as economists, undeterred by hostile criticism, seek to find and proclaim the cause or causes of this all but world-wide abnormal and terrible evil.

VII.—*Educational Experiments.* By JOHN G. KERR, M.A., Headmaster, Allan Glen's School, Glasgow.

[Read before the Society, 17th February, 1897.]

WHILE every one is more than willing to admit that the last word on the education of youth has not been said, the difficulty of saying anything new remains.

Montaigne, who may, without disrespect, be taken as a mirror reflecting the main drift of earlier philosophic opinion, holds that "the greatest and most important difficulty of human science is the education of children." This sixteenth-century finding, even after three centuries of progress, seems quite in consonance with the views of thoughtful people of to-day. No doubt, the aphorism (like many aphorisms) carries beneath the words a grave reprimand, and Montaigne, discussing the effects brought about by the school training of his time, quotes Seneca, "*Non vitæ sed scholæ discimus*" (we do not study for the service of our future life, but for the present use of the school). He criticises the school product as "awkward, maladroit, unfit for company or employment;" and adds, as his conclusion of the whole matter, "If the mind be not better disposed, if the judgment be not better settled, I had much rather my scholar had spent his time at tennis, for at least his body would, by that means, be in better exercise and health."

In the 17th century Burton places early education among the causes of "melancholy," rails at the "*aridi magistri,*" the "*Ajaces flagelliferi*" (stern pedagogues—great heroes wielding the tawse), and, under the cloak of Erasmus, declares, "*Præceptorum ineptiis discruciantur ingenia puerorum*" (the faculties of pupils are perverted by the stupidities of their teachers). This, although a seventeenth-century opinion, is very serious; all the more serious that, after the advance which has been made right up to the present hour, similar criticisms—couched, of course, in current phrases—are not infrequent.

The 18th century is richly studded with the names of great reformers, from among whom Pestalozzi and Froebel, Kant, Fichte, and Herbart send forth a radiance that illumines each successive stage of progress.

It is altogether beyond the scope of my present undertaking to deal with their contributions to education. That history accepts them as reformers raises the point that reforms were needed, and suggests adverse criticism of previous practice. With these remarks, I pass to more recent times, and to certain estimates which have been formed regarding the education of our country by men of ample knowledge and clear vision.

National education was in the air, and Thomas Carlyle, the seer, demanded "lastly, and rather firstly, and as the preliminary of all, would there not be a minister of education? Minister charged to get this English people taught at his and our peril! Minister of education; no longer dolefully embayed among the wreck of moribund religions, but clear ahead of all that." After fifty years this question still demands a reply.

To Carlyle education was vital. Nor was it with a hazy view of the desired end that he gave utterance to his opinions. Strong doctrine permeated his attestations. "What a boundless outlook," he cries (in "Shooting Niagara"), "that of schools and of improvement in school methods and school purposes, which in these ages lie hitherto all superannuated and, to a frightful degree, inapplicable; our schools go all upon the Vocal hitherto; no clear aim in them but to teach the young creature how he is to speak, to utter himself by tongue and pen, which, supposing him even to have something to utter, as he rarely has, is by no means the thing he specially wants in our time." Again, in his essay on "Chartism," he declares, "To impart the gift of thinking to those who cannot think, and yet who could in that case think, this, one would imagine, was the first function a government had to set about discharging."

Should any doubt remain about Carlyle's meaning, take his whole doctrine packed in a single sentence—one of the first pearls that fell from his lips—"The grand result of schooling is a mind with just vision to discern, with free force to do."

It may be urged that, although there were many defects in school education during the first half of the century, it is not permissible to suggest that these still exist to any great extent. "We have changed all that," say the school boards,

the inspectors, and the department. "We are going on right lines now."

That there has been some improvement is patent to every one. Magnificent buildings, constructed in accordance with the very last results of sanitary science, have replaced the dingy, ill-ventilated retreats of earlier years. On staff and equipment increasingly large sums of money are expended yearly, yet the ratepayer welcomes the added burden, and it might safely be said that this particular drain on the national exchequer is challenged only at the prompting of party politics. The citizen of to-day is immensely anxious about the education of his children. He realises the enormous part it plays in the conflict for existence, and he is willing to believe that we are making for better things. No one engaged in teaching dare question that belief.

But Herbert Spencer holds that true education is practicable only by a true philosopher, and adds, "Judge then what prospect a philosophical method now has of being acted out! Knowing so little as we yet do of psychology, and ignorant as our teachers are of that little, what chance has a system which requires psychology for its basis?" He fears that the pedagogue has but the dimmest notion of his pupil's mind, and presents it with utterly incomprehensible facts—generalisations—before there exist in it the things to be generalised, . . . and so on.

Without either admitting or denying the applicability of Herbert Spencer's words to present conditions, it should be pointed out that of late years the universities of Scotland have taken a considerable share in the training of teachers, and that special courses of psychology in its relation to education are provided, and therefore we may reasonably anticipate that the teachers of the future will receive a kindlier estimate than that just quoted.

I adduced Herbert Spencer, with his thunder, merely to witness to the existence of doubt regarding the satisfactoriness of schools. His words, after all, do not give much help. It is just possible that psychology, like mathematics, is more serviceable as offering an explanation or justification of a process or method than as a main instrument for original discovery in the domain of nature. At any rate, there is perhaps more helpfulness, as to the direction in which progress might be sought, in the simpler admissions made by Sir John Lubbock and the Duke of Devonshire—that education in our schools is too bookish—and in Mr. Gladstone's hint that a departure is needed.

The Right Hon. G. J. Goschen, who, among the great men of our time, stands distinguished for the deep interest he has taken in education, sets himself to combat the "acquisition of knowledge" idea. He, of course, does not depreciate useful knowledge, but he wants young people to be induced to think and exercise their minds in every possible way. He says that many boys go through their education without being stimulated to think at all. In the pursuit of "useful, saleable, and available knowledge," it should be remembered, he says, that education is the preparing of the mental faculties for the various duties that these faculties may be called upon to fulfil. He prefers that his young man should, at the start of life, have his mind not so much a well-filled store-house as a piece of machinery constructed to produce and supply unlimited stores over and over again.

In a somewhat similar strain, but with more specific application, we find Professor Gairdner urging that "the first lesson to be learned to make all other lessons possible is to deal very largely with things and not with mere words; to realise, as much as we can, all our instruction by making it our own through personal observation; to suffer nothing, if it can possibly be avoided, to lie on the mind as a dead weight of vocables, oppressing the memory and dwarfing the intellect." He deplores, with Faraday, the lack of training of the judgment in natural things. He objects to training that is doctrinal as opposed to experimental. He deals strong blows against the present routine of school life, with its ten years' burying of noses in books and papers, and mental and other arithmetic, and sympathetically refers to the old Scotch woman whose estimate of her boy's progress in school was to the effect that "sin' ever he gaed to the schule his edication's been stopit a' thegither." This onslaught was made seven years ago.

One more quotation and my preamble ends. In a special report presented in 1895 to the Committee of the Council on Education appear these words:—"There is, I think, some justification for the opinion that the predominantly bookish character of much of our common school education has certain practical consequences that are not desirable." Being official, this sentence is mild in form, yet bears an edge.

I have deemed it advisable to submit these references. In advocating what might seem to be departures from the beaten track, it is prudent to call in authority. The reformer must be free from the sin of originality.

The experiments referred to in the title, and to which I shall direct your attention shortly, have been in great measure suggested by such considerations as are embodied in the foregoing references.

Behind the conviction that we had not reached a perfect system of school training, and behind the belief that it might be profitable to strive at improving a small corner of this great field, there were necessarily certain rough views regarding the true nature and cause of the recognised deficiencies.

It seemed, in the first place, worth considering whether "subjects" carried the seeds of evil. Now, although it will become evident that I am inclined to recommend, as essential in a school curriculum, certain forms of work which might reasonably appear, in an education code, tabulated as "subjects," I feel that there is very little justification in attributing shortcomings in the work of our schools either to the presence or the absence of this or that subject.

Consider and contrast the relative simplicity of the older curricula with the variety and multiplicity now offered, yet the criticism of results is not strikingly different in its tenor. Further, we are aware, as our ancestors were aware, that, with fairly identical curricula, under fairly similar conditions, two different pedagogues of fairly identical scholarship and experience produce effects that differ so greatly as to seem of different orders altogether. The evil, when it exists, does not lie to any great extent in "subjects." We must look rather to the method and the process employed.

It may not strengthen the argument, but it will, at any rate, make my position clearer, if I quote, with appreciation, a word or two of the evidence given by the late Sir W. C. Siemens to the Royal Commission on Technical Education in 1882. His opinion was being sought by the Commissioners in view of the clamant demand for technical education in this country; he insisted on general education up to eighteen, if possible; he accepted classics, and would have his pupil trained both in languages and science, without reference to any predilection he might have; he considered it a mistake for grammar schools to have a classical side and a modern side; he objected to the German polytechnic schools as dulling by routine, and believed that the university idea did more for developing original thought.

This evidence of Siemens, indirectly at least, supports the contention that the solution of the school curriculum problem is not

to be found in "practical" education as ordinarily understood and too frequently asked for.

No doubt, there is another, but, unfortunately, less frequently accepted meaning of this phrase "practical education." Whewell, dealing in 1837 with the general question of teaching, uses it to describe "another mode of teaching, in which the learner has to do something for himself." Accordingly, one is not surprised to find that classics and mathematics are claimed by Whewell as occupying the very front rank of "subjects" of practical teaching.

If, then, on the one hand, we admit the justness of Whewell's views, and sympathise with the tone of Siemens' evidence, and yet, on the other hand, acknowledge that the lamentations, both ancient and modern, are not without cause, we are, as I have said, forced back from "subjects" to methods, from the teacher to the learner. This brings us to a quagmire, in which inattention, indifference, and the strap prevail. We want a way out. Herbert Spencer shakes the head sadly, and mutters "philosophy and psychology." However hard this saying, and however tangled psychology, save for examination purposes, may prove to be, despair is, to my mind, not an inevitable necessity. It is a first article of my belief that without some theory, let it be even the merest shred of theory, so long as it offers some kind of consistent working hypothesis, there can be little hope of escaping the Serbonian bog. Despite this, or, rather, in virtue of this, I am buoyed up with the hope that this shred of theory woven long ago is at our disposal and of profitable application.

The brain diagram, which I have here, is adduced, not to prove any proposition, but as offering some pegs on which to hang the essentials of my creed as to the teacher's function. The diagram is somewhat antiquated. It represents, in a rude way, the views generally held regarding two different modes of behaviour on the part of the brain, when response involving muscular actions succeeds stimulus from the outer world.

In the first case, we have the route travelled by the stimulus passing up an afferent nerve, received at a lower centre, the *optic thalamus*, and thence transmitted direct to another lower centre, the *corpus striatum*. From this centre, in virtue of messages received, there issue instructions along the efferent routes, and definite action follows. The simplicity of this is quite on a level with its intelligibility. Leaving the mystery out, this statement,

although immensely inadequate, is not a misrepresentation of physiological opinion.

The second way of behaviour brings in the cerebral hemispheres with the higher centres. It would seem that in this case the ingoing message cannot be treated with mechanical precision by the *optic thalamus,* and sent on direct to the express office. Information has to proceed to the higher centres, and the tracks along which impulses proceed upwards and outwards to the cortex are within the histologist's knowledge. At points here and there in the large sheet of convoluted grey matter active operations are set agoing. Messages fly from group to group, consultations are being held, conclusions are being come to, and definite courses of action are being resolved upon. Down to the appropriate lower centres come the results of these inter-actions of brain elements, and along the efferent nerves instructions are sent outwards. Should this language seem fantastic, I would seek shelter behind Professor Foster's phrases:—"The efferent impulses started by the stimulus undergo complex changes before they become sensations. Then come the psychical processes through which the appreciated sensations or perceptions, or apperceptions, as they are sometimes called, determine an act of volition. Lastly, there are the executive processes of volition, processes which, psychical to begin with, end in the issue of co-ordinated motor impulses, or, in other words start the distinctly physiological processes of the efferent stage."

Apart from the hesitation one has at the convertibility of a stimulus into a sensation, however complex the process, it would be absurd for me to say that I fully understand and endorse Professor Foster's pronouncement Nevertheless this quotation contains, as I think, that shred of theory which makes the work of the teacher not altogether haphazard or hopeless.

Foster's dictum predicates "will," and supports the fruitful saying of Professor Laurie—"The education of mind as reason is the training and discipline of will as power."

Let me add a thread or two more to the texture of this doctrine.

Foster maintains that in all the higher processes of the brain we must recognise that, in nervous materials at all events, "action determines structure," meaning by structure molecular arrangement and position; and to him the word "training" only suggests the reflection that the physiological interpretation of becoming easy by practice is "that new paths are made, or the material of old paths made more mobile by effort and use."

I dare not advance much farther in this direction. Huxley, when winding up his famous "protoplasm" lecture with the advice not to worry over things of which we knew nothing, and could know nothing, but rather to do what little good we could according to our lights, permitted himself to say "that our volition counts for something in the course of events." Twenty-four years later he placed a foot-note of correction, striking out "volition," and inserting, with the remarkable apology, "or to speak more accurately," these words, "the physical state of which volition is the expression." This apologetic recantation is of the nature of a challenge. To my mind there is more gain in courageously refusing to take it up; and I may add, if the correction, with all it implies, had affected my belief, I would thereby have been deterred from advancing a single opinion on the subject of education.

Let us see where we are. It is beyond all dispute that a multitude of our complex activities are purely automatic, and it may freely be granted that "what is inherited is organic structure fitting the organism for their automatic performance." Further, it is demonstrated that many automatic activities are possible without reference to the cerebral hemispheres. But it is accepted that all controlled activities involve the highest centres, the control taking the form of checking or augmenting the activities. The loop lines of the diagram are intended to suggest such action. Mysterious as the stages in the process may be, there is, so far, agreement among authorities. Even the mapping out in the cortex of areas specifically related to definite activities has been carried out in a manner so complete and so reliable that brain surgery has placed to its credit a marvellous record of beneficent operations. In the diagram, lines are drawn connecting directly points in the cerebrum. These lines represent what are sometimes called "association fibres." Now, it appears that while the fibres running up from the lower brain centres to the cerebral hemispheres, and also those fibres running from the cortex to the pyramidal track, exist in the brain of the newly-born infant, the association fibres linking centre with centre in the hemispheres are not established until after the brain has entered upon its duties, and accordingly psychologists assume that the association of ideas is a matter of individual establishment.

It is this aspect of conscious existence in which "action determines structure," that gives the teacher ground for hope. Yet there are difficulties for him on every hand.

He reaches the conception that the cerebral hemispheres, with their linked centres, control the lower automatic centres, only to be brought face to face with the question—What about the control of these controlling centres?

Faith must crown the edifice. He must take his stand with the volitional school. The working hypothesis which determines his own conscious actions practically involves a belief in the directing and controlling power of the Ego's own will, in virtue of which, to a great degree, thoughts are directed and feelings controlled.

Huxley's correction of 1892 must be laid aside as dangerous, if not incomprehensible, and there must be adopted rather the finding of 1868 when, uttering a solemn warning against systematic materialism as paralysing the energies and destroying the beauty of life, he maintained that the belief in volition could be experimentally verified, and that that belief stood on the strongest foundation on which any belief could rest.

Animated with such opinions, and strengthened by the latest teaching of physiology regarding the material effects that follow in the wake of effort, the teacher will treat his pupils, not as phonographs, but as living personalities. Every effort of attention he may manage to evoke, every effort of conscious intelligence he may discern, will be eagerly noted, not as an indication of progress towards an examination result, so much as a great step leading to improved capacity and power.

In this there is nothing new. I have merely brought forward a fragment of a great subject so that the details of certain forms of school work now to be considered may stand as applications of principle, and not as eccentric and desultory experiments.

I believe that the conditions under which school work is carried on encourage a disregard of the principle for which I contend. Over-teaching is the vice of the hour, and the advantage of securing the semblance of homogeneity in a class of from 60 to 80 living souls the inducement to error.

Accordingly I would submit that every method or, should you prefer it, every artifice that has the promise of stimulating intellectual effort in definite directions should be welcomed. For every effort implies will, and will, exercising itself under judicious guidance, determines lines of development.

To put my exhortation briefly, I should say to the teacher—think first of the pupil. Have no concern with the subject as a

something to be taught. The main purpose of a subject is to supply material on which the pupil is to be, not fed, but exercised.

I know of no subjects that cannot be used in this way, but I also know that most subjects are not sufficiently considered from that standpoint. We want to gather the cherries before we have prepared the soil, or have planted the tree. We are in a fever heat to get on. We must balance our books monthly or yearly, and we are too apt to forget that the business on which we are engaged does not yet possess any well-defined units wherewithal to express the results of our work.

But, although quantitative estimation of effects must always be illusory, there are signs known to the teacher, rejoicing his heart, and telling in unmistakable language that his boys are moving forwards. The posture of the body, the ring of the voice, the glance of the eye, convey to him, who can interpret the ingenuous signals of youth, immediate and reliable information of true progress being made.

I am told that the secret of success lies in getting boys so interested in their work that "they will go through life teaching themselves," and this, says Goschen, is the final test of an educational system, whatever its curriculum may be. Without any desire to traverse this opinion, it may be pointed out that, on closer examination, the doctrine affords no directly available assistance. In those unconscious indications, however, to which I have referred, lies a principle of far more value than the term "interest" can claim. This principle, if to save a periphrasis, you will accept an adjective, is the principle of functional pleasure.

Power and capacity develop slowly, and it is not given to youth to evoke at will pleasure in their work. But the teacher knows better than any other, better than the boy himself, why it is that the eye glints, the face firms, and the whole body moves responsive to some inner force. It is not interest, it is not pleasure in work, it is pleasure from the work, pleasure from the exercise of function. Formulating the principle brings no explanation.

The artist, the athlete, and the boy at his task experience this pleasure, not as a product of reflection, not in virtue of anticipated return for work expended, but as the direct, although uncalculated, accompaniment of effort itself.

If this conclusion is in accordance with experience, or, rather, if this interpretation of experience be accepted, it follows that the

key to the teacher's problem lies in stimulating the activity of the will, and his guiding principle a recognition of the part played by what we have termed functional pleasure.

Passing now from theory to practice, let me briefly describe, first of all, a group of experiments which are usually placed under the heading of "sense discipline." This designation, however, is misleading. The exercises, it is true, make demands on the senses, and are generally of an elementary character, giving rise to simple sense perceptions.

Yet my object has been not so much to influence the structure of the gateways of knowledge—their characteristics have been determined many ages ago—but rather to evoke effort, to encourage alertness of observation and readiness in discernment, and as a subsidiary, but never-to-be-forgotten object, to lay the foundation of attainments that will prove of service afterwards.

This appliance, known in some educational reports as the Allan Glen quick-sight revolver, needs little description. It consists of a board with a few fittings to enable it to rotate on a vertical axis, and with a ledge on which articles may be placed for observation. On the side remote from the pupils, printed words, or rows of figures, or sets of dots are placed. At a signal the board revolves, and the pupils must brace themselves up to grasp the words, note the figures, or count the dots. After graduated preliminary exercises of this kind the pupils are trained to catch a sentence, run up a sum of several digits, or represent on paper the various markings on the board, which, however, does not stay to suit the indolent or sluggish observer. For freehand and model drawing the board has been found of service. It can also be applied with great effect to fixing contour forms in the minds of scholars, and so giving fairly permanent possession of valuable geographical knowledge. Pictures are placed in position on the board, and the pupils are required to state what they contain as the board rotates. To train in comparing lengths, areas and volumes, examples of unknown dimensions are exposed side by side with those that are known. An advanced pupil might be expected to estimate the volume of a cube, his guide in the process being a known length of wood exposed simultaneously, or he might attempt to form some notion of the radius of curvature when only a segment or arc was exposed to view. Experiments of a successful kind have also been made in training the faculty of colour perception. In all cases the

exposure is of short duration. Alertness, acuteness, and decision are encouraged in the pupils by this discipline.

[The various purposes to which the board is applied were illustrated, and among other appliances exhibited in this connection attention was directed to sets of blocks identical in dimensions and appearance, but differing in mass, which were found of service in cultivating conscious comparison and discrimination as regards the weights of objects.]

I shall now consider that special phase of "practical education" known officially as "manual instruction," and not infrequently spoken of as "Sloyd."

The Sloyd movement appeared in its first stage under the auspices of August Abrahamson, at Näas, in Sweden. Abrahamson, who was a wealthy proprietor, had as his object the encouragement of home industries. His nephew, Otto Salomon, the recognised head centre, soon realised that a systematic instruction in wood-sloyd, in turning, chip-carving, saddlery, engraving, sewing, and cooking, developed qualities quite beyond mere mechanical dexterity. He saw that these general qualities of mind and body which education aims at fostering were promoted in the course of the exercises. Recognising these formative influences, he started a propaganda, and Sloyd entered on a second stage, and in time became part of the national system of education in Sweden.

In this second stage the utilitarian considerations of Abrahamson, and the manual dexterity implied in the name Sloyd, are no longer the main results aimed at. Salomon insisted, and his words carried conviction, that the importance of Sloyd in a national system depended upon its encouraging habits of order, accuracy, patience, industry, and self-esteem; in short, those qualities which affect success in life.

If, then, what the Sloyders claim is true, and it is true in great measure, it necessarily happens that there arises a demand for an explanation. The most decided reply comes from Sir James Crichton-Browne. He is dealing with the motor centres, and particularly with those associated with the hand, and remarking (1) that these motor centres had a limited period of growth (say from the fourth to the fifteenth year), and (2) that they were intimately connected by association fibres with other parts of the brain, he says—"It is plain that the highest functional activity of these—the motor—centres is a thing to be aimed at with a view to general mental power as well as with a view to muscular expertness; and as the hand centres hold a prominent place amongst the motor centres,

and are in relation with an organ which in prehension, in touch, and in a thousand different combinations of movement, adds enormously to our intellectual resources, besides enabling us to give almost unlimited expression to our thoughts and sentiments, it is plain that the highest possible functional activity of these hand centres is of paramount consequence, not less to mental grasp than to industrial success." He continues—"Depend upon it that much of the confusion of thought, bashfulness, stutterings, stupidity, and irresolution which we encounter in the world, and even in highly educated men and women, is dependent on defective or misdirected muscular training, and that the thoughtful and diligent cultivation of this is conducive to breadth of mind as well as to breadth of shoulders."

Without challenging the accuracy of Sir James Crichton-Browne's statements regarding motor centres and their relation to the processes of conscious thought, it is plain that, were we to push the principle even a little bit, we might be forced to advocate a a very early apprenticeship in a well-conducted shop as containing a promise of better things than our school system up to the present time has supplied. This very serious conclusion might seem justified by a reference to the number of so-called plain, practical men, who, despite what is designated a very defective elementary education, have, by their improvements, inventions, and discoveries, contributed materially to the wealth, prosperity, and industrial pre-eminence of Britain. Yet I very much question if one of these men would testify to the advisability of pushing Crichton-Browne's doctrine to its logical conclusion. Further, it must be remembered that these well-defined hand-motor areas, on which the physiologist places so great responsibility, occupy a relatively small portion of the great convoluted sheet of grey matter, and it is more than possible that the early direct training of these centres, at the expense of more important, though less perfectly defined centres, would not be profitable. My position, as is obvious from the earlier part of this paper, is not one of scepticism as to the value of the light which physiology throws on mental operations. My doubt and my fear is that this explanation of Sloyd, in its second stage, imposes upon it too heavy a burden.

I am inclined rather to help on Sloyd to a third stage, and submerge it under the general principle. I would advocate the extension of manual work in schools, mainly on the ground that of

all subjects on which to discipline the will there is none in which the elements of personal control and personal effort appear so much, and the domination of the teacher so little.

Some twenty years ago, at a time when Government grants offered not one penny of inducement in this direction, the Allan Glen Trustees, on the advice of the great headmaster of that school, Mr. Dixon (secretary of this Society for many years), arranged a course of manual training, which, with few immaterial changes, plays a part in the education of every boy in the school.

[The details of the course of workshop exercises were discussed, and there were exhibited specimens of work done in Allan Glen's School. This exhibit included elementary Sloyd exercises, simple and complex joints, examples of turning in wood and iron, and of pattern-making.]

I come now to the course of practical work in physics, with which we have been occupied very much of late years.

The extreme importance we attach to this course is, it must be confessed, not entirely dissociated from a money grant. On that account alone, we ought to feel indebted to South Kensington, and make recognition of the fostering care with which it has encouraged science teaching. Beyond this and above this, however, it must be urged that the Science and Art Department, in laying down these new lines of progress, has, in the most perfect manner, refuted the preposterous criticisms with which it has been assailed by some to whom its educational side was unknown. It is rather feeble to say, as the Commissioners said last year, that the Science and Art Department was never intended to be, in the strict sense of the term, a department of education. How could the best interests of instruction in science be advanced without regard to education? The department has risen superior to its critics, and the purpose underlying its regulations in connection with science schools commands our unqualified admiration.

It would be too much to ask you to follow me through the details of its treatment of even one subject; to realise the whole of its work would require intimate knowledge of the day-to-day working of such a school as ours.

I shall, therefore, ask your attention to some typical examples of the work done in elementary physics. The appliances, although of the simplest kind, have been designed with strict regard to reasonably accurate quantitative measurements. Although our apparatus has, in most cases, assumed its present form after many trials and much labour, there is no ground for placing a claim for originality

so far as principles are concerned. That lies in another region altogether. But it is claimed that we have solved, and are solving, difficult problems connected with the devising of methods and instruments whereby the individual pupils in large classes will receive all the advantages that practical work in physics can give.

[Mr. Kerr at this point described some groups of pieces of simple physical apparatus used by his pupils, and demonstrated to the meeting the manner in which this practical work was carried on in Allan Glen's School. He also explained, using diagrams, the methods followed in recording observations and drawing conclusions from them.]

During the progress of such work as I have described, the pupil is brought face to face with facts. He arranges his own appliances wherewith to interrogate phenomena, makes his own observations, and records, what he has seen and what he has measured, in a plain manner. He works his way into a comprehension of the meaning of volume, mass, density, force, elasticity, heat, temperature, &c. He exercises himself in plotting out results, and uses his "graph" as an instrument for further investigation. The practical work in electrostatics and current electricity is considered and arranged with the same object in view, namely, the getting at the fundamental ideas through the facts, and the obtaining a secure grasp of those ideas by dealing with the facts quantitatively. Whatever may be the future line of life followed by the pupil disciplined in this manner, you will, I feel, agree with me in believing that he will approach the problems of the world with a just regard to cause and effect, a keen sense of precision, a fertility of resource, and a self-reliance born of successful self-directed effort.

In the discussion which followed the reading of the paper,

Professor GAIRDNER said that, in remarking upon the admirable paper, he was only following up the line attributed to him in the quotation read in the paper itself. There was a disposition in some quarters to treat any criticism of the imperfections in our educational system as if it were an attack upon, or a disparagement of, the old classical and linguistic training; and the new device of the "modern side" in schools might, perhaps, be taken as an attempt to propitiate this feeling by enabling those who favoured it to neglect some of those things which were formerly considered to be all in all. But this was not at all his (Professor Gairdner's) view of the position; therefore he was glad to hear Mr. Kerr say

that the question was one, not of subjects, but of methods. That was the true view of it, for it was quite possible to teach what was called "science" or any other "modern" subject by methods just as bookish (to use Sir John Lubbock's expression) as ever were applied to Latin and Greek; and, what was more, it was often done, with the result of complete failure as to conveying fruitful ideas of science or of anything else. Hence it is quite possible to have an education with a "modern side" which might be, if possible, more defective in method than a purely classical education ever was. On the other hand, the cultivation in schools of methods such as those which had been brought before the Society that evening would in the end be of the greatest possible value, not for science subjects only, but throughout the whole range of a liberal education. For the fault or flaw implied in the over-bookishness of education in general is not that it leaves out this or that subject, but that it leaves out of the training of the young brain a whole set of faculties implanted there for purposes which are not opposed to, but very much in accordance with, the education of the whole man. Faraday saw this very clearly more than forty years ago, when, with characteristic modesty, he pleaded on behalf of scientific education before the Devonshire Commission, confessing himself at the same time to be an uneducated man. Faraday knew from his own personal experience that children have a ready appetite for what he called "real knowledge," that is to say, the demonstration of facts and principles directly from objects by the way of observation and experiment. He knew also that the most elaborately educated men in England at that time—the men of Eton and Harrow and the Universities—were so destitute of this kind of knowledge that they not only could not take it in (as a child would do) but were a prey to every kind of quackery and delusion, which a mind properly instructed in the A B C of real knowledge could not entertain as truth even for a moment. Hence he argued for the necessity of introducing more largely a new kind of instruction, not to displace the older methods, but to supplement them. Faraday did not at all make light of the difficulties in the way of his views of education, and the first and greatest of difficulties was to find the teachers. "You want men who can teach," he said, "and that class has to be created; it is not the matter, it is not the subject, so much as the man." In other words, science taught upon the old lines of bookishness, was, in his eyes, no science at

all. It may be admitted that some advances have been made in this direction in the better class of our schools of to-day, but still the great want is the want of teachers who can apply the new method, even in its most elementary manner, to the A B C, as Faraday said, with the knowledge and clear conviction of its value that Mr. Kerr has shown us to-night. Sloyd is, no doubt, also a step in the line of progress, because Sloyd, in training the hands, and especially the right hand, becomes a discipline also for some of those faculties, or, to put it in another aspect, those convolutions of the brain that are most differentiated in man as compared with the lower animals, and which stand next in order to the great human faculty of speech. But those elements of natural science which Mr. Kerr takes in hand after the manner that he has demonstrated to us to-night, are more of a discipline than Sloyd, and are exactly on the lines which Faraday desired to see established as an essential part of education—that is to say, "real knowledge"—the knowledge of things, and not mere propositions about things, committed to memory or read out of books. It would therefore be very interesting to be informed by Mr. Kerr (and he, Professor Gairdner, was curious to know) if these experiments of his in this real and novel training accommodated themselves well to the older side of school work, or if, as some thought or feared, they were likely to be antagonistic to it. The principle was so obviously sound that it would be hard to convince him (Professor Gairdner) that it could not be brought into harmony with classics or with any other subjects. And, curiously enough, it was not even that great man of science, Michael Faraday, who first put this principle into a clear and definite expression, for more than three centuries ago, an old grammarian, Julius Cæsar Scaliger (who, by the way, happened also to be a physician), in a book which was certainly not in any way a striking example of the method in practice, had formulated the principle of the scientific as opposed to the scholastic method, in these memorable words, which, even in the present day, can hardly be improved upon as a definition in brief:—"*Rerum ipsarum cognitio vera e rebus ipsis.*"

Mr. KERR, replying to Professor Gairdner's question, said that there was no antagonism, either in spirit or method, between the type of training described in the paper and the older side of school work. There was not even any serious interference so far as con-

cerned the time available for necessary school subjects. He felt that, for disciplinary purposes, Latin—although it did not call into play all the activities involved in the study of practical physics—yet in no way stood in contrast to the newer subjects. The same main lines must be followed in all cases. From the very early stages, the pupil must be induced to note relations and appreciate the meaning of inference, and, all through, progress and profit could only come if most rigorous attention were given to the forms of speech by which relations were expressed. He believed that the scientific method as applied to the study of natural phenomena must necessarily play an all-important part in linguistic training; at the same time he felt that full advantage could not be received from the newer work unless it were associated with a well-considered language course, and he was glad to say that the present school day was quite long enough to make such mutually supplementary work possible.

VIII.—*The Andersonian: A Centenary Sketch.* By Professor A. H. SEXTON, F.R.S.E.

[Read before the Society, 20th January, 1897.]

THIS is an age of centenaries. Men are beginning to realise that the present is the outcome of the past, and that however great may be the things which are achieved to-day, they have only been rendered possible by what has been done before, and there is therefore an increasing tendency to recognise the work of pioneers—men who made steps in advance—small, maybe, but yet which were the commencement of eras of development. What more natural than that when a century has rolled away we should by some suitable celebration call back to our memory the man whose work has stood the test of time, has proved itself by a century of growth to be of permanent value, whether that work relates to art, science, literature, religion, manufactures, or any other of the energies of life.

For a man's work to endure unforgotten through the turmoil and conflict of 100 years, and still to live, is a sign that it has had some influence on the past and some promise for the future, and that he deserves, at least, a small niche in the temple of fame.

For these reasons I venture to call attention to the work of John Anderson, whose best memorial is the "Andersonian," so long and so intimately connected with the educational advancement, not only of this city, but of the whole West of Scotland.

John Anderson, F.R.S., Professor of Natural Philosophy in the University of Glasgow, died on the 13th of January, 1796. Though he was an able man and an excellent teacher, and performed his duties with credit, he cannot be ranked as a great physicist or a scientific discoverer, and his career, taken by itself, was not such as to call for any centenary honour. But the work which he did in his life, and, still more, that which he caused to be done after his death, left such a lasting impress on the century which followed, and gave such a new trend to the education of the country, that

the work, if not the man, calls for some note. As in all such cases, however, it is impossible to realise the work without knowing something of the man.

Anderson held the Chair of Natural Philosophy in the University of Glasgow from 1757 to 1796, and during this long period—nearly forty years—he was constantly labouring for the scientific education of the people. There was nothing in him of the scientific recluse, buried in his library or his laboratory. He was a man of the people. He visited the various workshops of the town—few and small as they, no doubt, then were—and made himself familiar both with masters and men. He saw the methods they used in their daily work, and he saw how much better things could be done, if only the men understood the principles on which the operations they were daily performing were based. Thus he was led to the idea—which has since been recognised as the basis of all real technical education—of giving instruction in science to those who have to apply scientific principles in their daily work.

His lectures at the university were for university students, who were expected to have a good general education and some knowledge of mathematics—the workmen and masters had neither. Would it be possible to arrange a course of lectures on natural philosophy which would be within their reach?—to make experiment, to a large extent at any rate, take the place of mathematical reasoning? He asked himself these questions, answered them in the affirmative, and at once tried to carry out the idea. He arranged for a new course of lectures on what would now be called experimental physics, and this course he continued annually till his death.

The lectures were given three days a week, and the students he wished to reach were employers, foremen, and others engaged in the various industries in the town. As the lectures were given during the day, it is evident that not many workmen could attend, though it must be remembered that the conditions of labour were very different at the end of the last century from what they are now. In place of the great factories and shops of to-day, with their crowds of workmen, often little more than machines, there were very small shops, each employing only few hands and apprentices, and therefore there was much more liberty among them than is possible now.

As those who attended these lectures were not strictly speaking

students—certainly they would not have been able to pass an entrance examination—and sometimes even came in their working clothes, it would have been absurd to have expected them to don the red gown, then, as now, the badge of a Glasgow student. He therefore dispensed with it in this class, and they came to be known as his *non-togati*, or ungowned students.

As a text-book for this class he published his "Institutes of Physics," which was very popular in its day,—at least five editions being issued before the death of the author.

As he grew older he more and more realised the importance of his work among the workers, and he became more and more attached to his *non-togati*. He soon saw that there was great danger—nay, almost certainty—that the work he was doing would end with him, and that at his death the popular classes would collapse. The work was out of the line of the usual university teaching, and it was most unlikely that his successor, whoever he might be, would care to continue it. The university authorities, too, looked coldly on it. He had, for various reasons, been in constant conflict with some of his colleagues and the university authorities; and therefore the fact that the work had been his special hobby would tell, with them, rather against it than for it.

So he set to work to devise some plan by which this work—technical education it would now be called—on which he had set his heart, might be carried on and extended after his death. He realised that what he had done was only a beginning, that, with the weight of his university duties upon him, hampered by university customs and traditions, he had been able to do but little; and that, if real good to the community was to result, the work must be carried on by others, on a larger scale and in a freer atmosphere.

He thought out the matter for years, kept it steadily in view, accumulating books and apparatus from time to time as occasion offered, and, when he had matured his plans, he set them forth in his "last will and testament," dated May 7th, 1795, and a codicil thereto, dated 4th January, 1796.

He decided to leave all his property to found a new institution, which he desired to be called "Anderson's University," and which he desired should be in reality a people's university, open to all, but intended specially for those who needed the knowledge which the various professors would impart in their daily work. He

arranged everything down to the smallest details, and named those who were to be the first trustees and professors.

Mingled with sound common sense and practical ability, Anderson had yet a great amount of the idealist in his nature, and whilst, on the whole, his ideas and plans were excellent, some of them were very fanciful. He must have known also that the scheme which he propounded was rather that for an ideal university, which might be dreamed of or looked forward to as a goal to be reached in the far future, rather than one which he could hope would be realised within a reasonable time of his death. Had it been possible to carry out his plans in their entirety, Anderson's University would not only have been far in advance of the University of Glasgow, but of any university then existing, and, in some respects, of any that exist to-day.

That his plans were too large for the times he certainly knew, and we must take much of what he put down as representing what he thought an ideal university should be, rather than what he hoped to be realised at once in his university, and he added the common-sense *proviso* that if it were found to be impossible to carry out the whole scheme, then part should be attempted, and preference should be given to a chair of natural philosophy.

According to his scheme, there were to be four faculties—arts, medicine, law, and theology; in each faculty there were to be nine professors, and, in addition, there was to be a school under the same body of governors.

The university was to be governed by eighty-one members, divided into nine groups of nine members each. The groups were tradesmen, agriculturists, artists, manufacturers, merchants, mediciners, lawyers, divines, natural philosophers, and kinsmen of the founder; full particulars being given in the will as to who was to be included under each head. The trustees were to elect from their number a board of nine managers, who were to control the working details of the institution, and one of these was to be elected as chairman. Though Anderson was an extreme radical, and was in sympathy with the French Revolution, the constitution of his university was not democratic. The first eighty-one trustees were nominated in the will, and vacancies as they occurred afterwards were to be filled by the board itself. The division into groups was to make the board representative of all classes of industry, and, fanciful as the arrangement may seem, it continued

in existence till 1886, a period of 90 years, and seems to have worked fairly well.

Three classes of persons were absolutely excluded from being members of the board of trustees.

1. "All who were even remotely connected with the University of Glasgow."

This exclusion was, no doubt, due, to some extent, to the differences which he had had with his colleagues. He himself gives his reasons.—"The intention of this institution being to keep the two universities completely separated in every respect, from which it is hoped much good will ensue;" "and the irregularities and neglect of duty in the professors of Glasgow College will naturally, in some degree, be corrected by a rival school of education." He recognised the value of competition in keeping all parties well up to the mark, and whilst the separation no doubt thus benefited both institutions, it also produced more than mere rivalry in good works—a large amount of ill-feeling and bitterness.

This proviso of the will was modified by the Anderson's College Act of 1877.

2. All persons connected with the government of the city of Glasgow.

The Lord Provost, the eldest Bailie, the Dean of Guild, and and others were appointed visitors, and the reason given for their exclusion from the board was that he wished "the visitors to be a check and control upon the trustees and ordinary managers," and, on that account, to have no other connection with the institution.

3. Professors and members of the teaching staff.

Anderson saw in the University what he considered to be evils brought about by the members of the teaching staff having in whole or in part the management, and therefore he excluded them completely from the government of his university, quite ignoring the fact that the members of the teaching staff must necessarily have more knowledge of the needs of the students and the details of working than any one else possibly can. In the present constitution of the college, whilst the two first regulations have been completely, and rightly, set aside, the third remains in full force.

Anderson was buried on January 16th, 1796. The executors met as soon thereafter as possible, and resolved to call a meeting of the nominated trustees. This meeting was held on March 23rd

in the Tontine Tavern. The trustees decided to accept the trust, and appointed Dr. Peter Wright chairman.

The property available was totally inadequate to carry out any considerable portion of the scheme. There was about £300 in cash, and a large collection of apparatus, books, household furniture, and wearing apparel,—the total value being about £1,000, and out of this some liabilities had to be met.

The trustees had three alternatives—they could let the trust drop altogether; they could hold it in abeyance until a more convenient time for making a start; or they could make a start in a small way, and trust to future developments to make the college what the founder intended that it should be.

Fortunately they chose the last-named course. Having decided to start, they took up the matter with great energy, and lost no time in putting the scheme into execution, feeling that what had to be done had better be done at once. Frequent meetings were held, sometimes in the Star Inn at the top of Glassford Street, and at others in the Tontine Inn.

The trustees decided to start with one professor, and, according to the instructions of the will, this must be a Professor of Natural Philosophy, and, as it would clearly have been absurd to call an institution with one solitary professor a university, they decided to start as "Anderson's Institution," leaving the taking of the more imposing name till circumstances should warrant its use.

Application was made by the trustees to the magistrates of the city for a "seal of cause," so as to give them a corporate existence. This was granted on June 9th, 1796—the magistrates feeling that the proposed institution "will be of great public utility, and conducive to the improvement of that branch of science (*i.e.*, natural philosophy), and is therefore deserving of the countenance and protection of public authority."

Two difficulties had then to be faced—the selection of a professor, and the finding of a suitable place in which the classes could be held. Anderson—in the will—nominated his assistant, W. M'Ilquham (or Meikleham), as first Professor of Natural Philosophy. He was approached, but for a long time he declined to state definitely whether or not he would accept the position, and in April he sent into the trustees a claim on the estate for £100 for assistance given to Anderson during his illness. The trustees offered £50 in settlement, or, if that were declined, to refer the matter to Dr. Reid, whose award was to be accepted by both

parties. The reference was agreed to, and Dr. Reid decided that the £50 was enough. Meikleham thereupon declined to accept the chair. Advertisements were therefore inserted in the Glasgow, Edinburgh, and London papers inviting applications for the chair.

The number of men with any scientific training whatever was then very small, and of these few were qualified for the work which had to be done. The selection, too, was of the utmost importance, for on it all felt that to a large extent depended the future of the institution—indeed, whether it should be a success or a failure. There is no record of the number of applicants; two local names are mentioned in the minutes; but the preference was given to a young Englishman who was then lecturing in Liverpool—Dr. W. Garnett.

Garnett was a medical man, an Edinburgh graduate of high scientific attainments, who had made considerable reputation as a lecturer on chemistry and allied subjects in Liverpool and other towns in England, and also in Ireland.

Careful inquiries were made as to his character and ability, and he was offered the appointment at a salary of £200 a year. He wrote accepting the offer on May 7th, 1796, and thus became first Professor of Natural Philosophy in Anderson's Institution.

The other difficulty, that of rooms, was soon overcome. The trustees appealed to the Town Council for the use of two rooms in the new Grammar School (now 204), George Street, and this was at once granted. One of the rooms was fitted up as a lecture room, the other as an apparatus room. There then remained the books and the household furniture, which, according to the codicil of the will, were to be removed to a suitable house, which was to be purchased or rented by the trustees, and was to be occupied by the professor of natural philosophy. A house was secured in M'Leod's Land, George Street, and there the things were put.

Great care was to be taken of the books and papers. The professor was to have free use of them, but, under no circumstances, were they to be allowed out of the house; if any professor allowed them out of the house in which they were kept, he thereby forfeited his office; and if the things could not be kept, in accordance with the terms of the will, by the managers, they were to be handed over to the Royal Infirmary—a clause which afterwards led to some little difficulty.

Garnett reached Glasgow early in October, and at once threw himself heartily into the work. As there was only one professor, he naturally made his courses of instruction very wide, embracing, as far as possible, both natural philosophy and chemistry; indeed, the chair soon came to be regarded as covering both subjects, and until each subject had a separate chair the professors were usually more distinguished as chemists than as physicists.

In arranging the work, not only the letter of the will, but Anderson's main idea of a people's university, was kept steadily in view.

A regular course of lectures on physics was established, meeting every day. On four days the course was to be a mathematical course similar to that given in the university, and on the other two days it was to be experimental without "any mathematics," much on the lines of the experimental course which Anderson had given for so many years in the university.

This course was commenced at once, but the distinction between the two portions does not seem to have been kept up, as Garnett, writing in 1799, speaks of it as one course meeting for one hour every day. In his "Tour through the Highlands," published in 1800, he gives an elaborate account of the subject matter of this course, and concludes by saying—"I trust I may be allowed to say that there is no course in Britain which comprehends so much, and is at the same time so full on each subject, and this arises from a particular attention to economy with respect to time. The lecture begins precisely at the hour; all recapitulation is avoided, and what is usually introduced to spin out less comprehensive courses carefully excluded," which shows that Garnett had no small opinion of his own merits as a lecturer.

Another step was taken at the opening of the institution, which, if not according to the letter of the will, was certainly according to the spirit of the intentions of the founder. As the popular lectures were intended for workmen and others engaged in industries, why should they not be given at a time when such could attend. Anderson, at the university, would probably not have found this possible, but now in the new institution any changes that were thought desirable could be made. So two evening courses of lectures—one on physics and one on chemistry—were arranged, these being illustrated, as far as possible, by experiment. These were the first systematic evening science classes in the kingdom, probably in the world.

As it was expected that considerable numbers would attend the evening classes, the Trades' Hall in Glassford Street was taken for them. It had been suggested in the codicil of the will to obtain this hall for all the lectures, but various circumstances prevented it being secured, except for the evening lectures.

In November, 1796, the institution was opened. Garnett's success was instantaneous and extraordinary. The class rooms were filled to overflowing, and students could not be accommodated; indeed, when in 1798 there was a suggestion made to lower the fees of the day classes, it was negatived because the class rooms were so full that more students could not be accommodated.

In the first year 972 students joined the evening classes; and though in the following years the numbers fell off a little, the success continued, and the attendances were always large. It must be remembered that at this time the population of the city was only about 70,000.

Another innovation in academical usage, made at the start, was the admission of ladies to the classes.

Anderson had specially stipulated in his will that there should be classes for ladies on the same terms as for men. Garnett and the trustees went a step further, and threw open all the classes to both sexes alike, a step which fully justified itself by its results. So a hundred years ago Anderson and Garnett settled the question of scientific education for women by practical experiment, though some old fogies of to-day do not seem to realise this, but speak and act as if the question were still an open one.

Nothing succeeds like success. No sooner was the institution seen to have taken a hold on the people than various friends came forward to help. A home was secured for the institution by the renting of the old flesh market in John Street, which was altered and fitted so as to provide a good lecture room, with laboratory, store rooms, and library attached. The lecture room was circular, with a diameter of 45 feet, covered by a dome, and was conveniently arranged for the purpose. The new premises were occupied in 1798, and a few years later the building was purchased by Mr. Oswald, of Shieldhall, and handed over to the trustees on certain conditions.

Anderson had left a good stock of apparatus. This was added to by other donations, and Garnett brought a considerable quantity with him; and he says, "The apparatus is unquestionably the most complete in Britain."

Anderson's books formed the nucleus of a library, to which many additions were made, and this is still preserved, apart from the general library of the college. The apparatus was in charge of Mr. John Parsell, who had been "demonstrator and amanuensis" to Anderson.

Garnett's career in Glasgow was short. Then, as now, success often led to London. Count Rumford, who had devoted a large amount of time to the study of education, founded the Royal Institution in London almost exactly on the lines of the Andersonian, though their subsequent development has been very different. He wanted a professor for his new institution, and where could he find a better one than he who was being so successful in Glasgow. The offer was made and accepted, and in 1799 Garnett removed to London, and was succeeded by another man whose fame has become world-wide—Dr. George Birkbeck.

Of the subsequent history of the institution thus propitiously started but little need be said. In 1828 the new Grammar School in George Street, where, it will be remembered, the first class meetings had been held, was purchased, and the classes removed to it, and this building—which is still occupied by the college—has become familiar to generations of Glasgow men as the "Andersonian." At the removal the trustees adopted the name which the founder had given—"Anderson's University." In 1877 this was changed by Act of Parliament to Anderson's College, and in 1886 the college was amalgamated with other institutions, and the name once more changed to "The Glasgow and West of Scotland Technical College." The change of name cannot but be regarded as being unfortunate. The principal institution other than the Andersonian, which was included, was the College of Science and Arts, formerly the Mechanics' Institution, which itself was an offshoot of the Andersonian, and these institutions could well have been reunited under the old name, and thus have retained the historical connection—always valuable—which now seems likely to be lost. Is it too much to hope that when the next change is made, and a new building is erected, the old name may be resumed?

The college never took exactly the lines which the founder intended. Of the four faculties, only two—those of arts and medicine—were ever started, and these had a long and prosperous existence. It is true the old institution has now been separated into two, but they are still the two faculties of the old college,

though under different management. On the arts, or rather, as it has now become, the science, side, the one professor of 1796 has developed into 11 in 1896, with 16 lecturers and a host of assistants.

It is not necessary to give a list of the distinguished men—living and dead—who have filled the chairs during the last 100 years, and who have made the fame of the Andersonian world-wide, nor of the larger number of men who have left their mark for good on the world who received their education within its walls, for the names of not a few are familiar to all. The institution, like all others, has had its ups and downs, but, on the whole, it has prospered and gone on in the right direction, doing good and useful work for Glasgow and the West of Scotland, or, rather, for the world, for its students are scattered far and wide over sea and land.

It is not too much to say that there is hardly a prominent Glasgow man during the last century who has not been in some way connected with the Andersonian, and the connection between the staff of the Andersonian and this Society has also been most intimate.

Important as the Andersonian has been to Glasgow, it is not on that account only that its centenary is noteworthy, for its influence has been far more than local. It has had a vastly greater national importance as the first step in the direction of technical education (which some seem to think is the exclusive product of this generation), and it was in fact, if not in name, the first technical college. Other institutions, much on the same lines, were soon established elsewhere. In 1823 the first "Mechanics' Institute" was formed as an offshoot from the Andersonian, and from this sprung the London Mechanics' (Birkbeck) Institution, and many others all over the land, many of which are now returning, more or less, to Anderson's ideal as technical schools.

The year 1896, therefore, marks not only the centenary of Anderson's College, but also of—

1. Technical education as marked by the opening of the first technical college;
2. The foundation of evening science classes;
3. The opening of college classes to women;—

and surely these are of sufficient importance to deserve a passing notice.

IX.—*House Sanitation.* By Neil Carmichael, M.D., F.F.P.S.G., Keith Medallist, Royal Scottish Society of Arts, 1880.

[Read to the Architectural Section, 1st March, 1897.]

The character of the soil on which a house is built is often a matter of great importance, with respect, first, to possible dampness and, second, with regard to the ground air with which it is permeated. Dampness of the foundations and basement of a house tends materially to render the house unhealthy. It renders the atmosphere wet and cold, and it tends to the development of fungoid and bacterial organisms under the floor, on the walls, and in all organic matter subjected to its influence in a more or less warm atmosphere. This fungoid and bacterial growth is in many ways injurious to health, and, when acting through milk or other nutrient media on the human system, may cause many serious disorders—possibly even diphtheria itself. But the air of the soil may of itself be a source of danger. All soils contain air—some as much as 40 to 50 per cent. This air is, for respiratory purposes, a very impure one. It contains often about half the normal quantity of oxygen, and about twenty times the amount of carbon dioxide which are found in pure air. It also contains ammonia and sulphuretted hydrogen, which, with the excess of carbon dioxide, are the products of putrefaction in the soil. In cities it often contains considerable quantities of coal gas. When a house is built directly on such a soil, or even when raised a few feet above the soil, the walls enclose an imperfectly ventilated space. The heat of the house and the draught of fires suck up the ground air, which thus comes to be one of the sources of air supply to the house. That this air should be supplied to the house, especially during the night, when doors and windows are closed, and when the inmates are subjected to its influence for long periods, is seriously objectionable. It provides the conditions of slow poisoning, to which are added the risks from damp and from putrefactive organisms.

How are these dangers to be averted?

If possible, a dry soil should be selected, and one with such a slope as will tend naturally to drain it. But, as it is not always possible to have any great choice as to site, especially in cities, the soil should be made dry by thorough subsoil drainage. But as this does not obviate the danger from ground air, it becomes important that the *whole basement* should be laid with concrete or other comparatively impervious material, and that this layer should extend outwardly beyond the walls to an extent of three or four feet. This should be done in all cases, whether the soil is comparatively pure or is an artificial one formed of organic refuse of filthy character. There should be no possibility of the air in the soil under the house being drawn into the house. The necessity for a damp course in the walls is so well recognised that it is unnecessary to discuss it.

The next point which requires notice in connection with the house is the question of drainage. What is required is the complete removal of all waste matters as speedily as possible, by proper appliances, and the exclusion of the products of putrefaction in those appliances from the house. Much on this subject is now clearly agreed upon, although on minor matters there are still differences of opinion. On a few points only is there any occasion in this paper to make comments:—

1. All appliances for removal of waste—water-closets, baths, sinks, with their traps and pipes—should be in shafts or towers, shut off by doors from the house proper. This might not be imperatively called for if the pipes and joints were always sound, but it is so difficult to maintain such a condition of constant soundness—as is shown by results of smoke tests—that it is advisable that the house proper should be saved from the risks of such defects. All may be sound this month; next month there may be serious defects.

2. Receptacles, closets, baths, traps, should be so constructed as to be easily flushed and to retain no filth. Pan-closets are bad beyond any defence.

3. As to the material of the appliances, much remains to be desired. Earthenware closets, basins, sinks, lead or iron soil pipes and traps, clay drains and traps outside, with occasionally iron or copper drains, are the universal appliances. Earthenware and clay are porous materials, notwithstanding the surface enamel or glaze which at first protects them. The glaze soon cracks under the action of ammonia and the potash or soda of soap, and the

basins and the drains become soaked in their substance with putrefying filth. A wash-hand basin, or a closet long in use, becomes a highly odorous and an offensive appliance. Break up an old basin or an old drain pipe and you at once see the filthy character of the substance. An old drain pipe in its substance contains a large amount of organic material yielding ammonia and albuminoid ammonia. What we require is a material which is non-porous in its substance, and smooth on its surface, such a material as glass. In 1856, a patent was taken out for glass as a material for drains, but though it has been recommended by Dr. Richardson and others, it has not come into use. At first, when suggested, glass was too costly to be generally used. Now it is cheap enough. The main difficulty lies in the moulding of it. For drains and soil pipes this could be done if there were a demand for it, but for traps and closets there is probably, at present, no satisfactory process. The first cost of glass drains and soil pipes would be greater somewhat than the cost of the material at present used, but the durability would be much greater, and the certainty that there would be no leakage through its substance of gases or liquids into the soil, and into the house would be a decided recommendation. Glass stands a much more severe strain than earthenware, and is not so readily broken.

4. One of the weak points of our drainage system is the unsatisfactory mode of jointing pipes. This does not refer simply to the joining of drain pipes with earth or clay in place of cement. The best cement joint yields frequently from the vibration or the subsidence of the soil or of a portion of the pipe. The whole drainage apparatus should be as firmly jointed as are the water pipes or gas pipes. They should be made, not simply water-tight, which they often are not, but air-tight. Possibly for this purpose it may be necessary to clamp the joints; certainly if glass were used it would be desirable to clamp the joints, using washers of gutta-percha or india-rubber, and making the whole system air-tight except for the ventilators at each end.

5. Where should traps be placed on the drainage system? It is recognised that all points of connection of the house appliances —baths, closets, sinks, basins—should be shut off from the soil-pipe air by traps. Should there be traps at the junction of the soil-pipe with the drain? Should there be a trap at the junction of the drain with the sewer? On these points there are differences

of opinion and of practice. The object of a trap is frequently stated to be the exclusion of *sewer* air or gas. It is supposed by many that the injuries which result from defective drainage are due to *sewer* air. That is a serious mistake. It is not *sewer* air, but *sewage* products—sewage air, if you choose the term—which do harm. In a sewer in which is constantly flowing a greatly diluted sewage, and which is well ventilated, the air is not a very foul air, containing very few bacteria, and is, indeed, a much purer air than that breathed in many bedrooms. The air of a drain or of a soil-pipe is rarely so pure as the air of the sewer into which it discharges; and when the drain becomes coated with filth, intermittently splashed with foul water, and when it becomes loosened at the joints, roughened on its surface with deposit, tilted by subsidence so as to retard the flow, or, perhaps, broken in some part, the retained organic matter becomes putrid and renders the contained air very impure. The injurious effects which are found resulting from defective drainage are very frequently due to the blocking of a drain or to escape from a joint of a drain, with consequent collecting of excrementitious matters. If a drain were always clean, always sound, it might be safe to dispense with the trap at the foot of the soil-pipe, but, as the dangers most to be apprehended from our present system of drainage lie in the drains rather than in the sewer, it is surely well to shut off the drain air, so that the effects of any defective conditions of the drain may be prevented from telling on the house. It is argued that, as the drain air passing up through the soil-pipe is shut off from the house by the house traps, a trap at the junction of the drain and soil-pipe is unnecessary. If the soil-pipe were always sound, and especially if the joints of the house traps with the drain were always reliable, always in perfect condition, this argument might apply; but, as experience has taught us, this is very frequently not the condition of matters found. We are dealing with apparatus and arrangements very liable to defects, and we must select the plan that will to the largest extent minimise the risk from such defects. It is better that, if a joint of a house trap becomes loose, the air which it admits should be the air of soil-pipe only—the cleanest part of the system—and not also the air of the drain. If the drain becomes foul or choked, not much if any harm may be done to the house if a trap at the foot of the soil-pipe cuts off the air connection. As to the trap at the junction of the drain and the sewer, it is much less important, and

unless it is a ventilating trap, admitting pure air freely to the drain, it is probably of little use.

6. It is agreed that all drainage pipes should be freely ventilated —that is to say, open to air at both ends. It is agreed that drain pipes should be laid on a solid bed, such as concrete.

7. The mode of testing drains and soil pipes for leakages at present most in favour is the passing through them of smoke under pressure with the ends of the pipe closed. This, with sufficient knowledge of the sources of fallacy, works very well, but if our pipes were made in their substance and in their joints as tight as they ought to be, then a pneumatic test—air pressure with a pressure gauge—would determine absolutely if a pipe were sound. If defects were found—that is to say, if it were found not air-tight—then the location of the defect might be sought by the smoke test.

The next subject to be considered is that of ventilation. This is recognised in a general way as one of the most important problems concerning the healthiness of houses, and yet not much has been done to render ventilation easy and constant. The means of ventilation usually provided are chimneys, which act when fires are used, but which, when the weather is warm and the air close, have usually their dampers closed; windows, which are rarely opened when the rooms are occupied, even during a whole night; and doors, which are usually kept closed. Fortunately doors and windows rarely fit tightly, and the flooring and belting of rooms have many seams, and so people are prevented from poisoning themselves to the extent to which otherwise they might. The only incentive to opening a door or window which is usually operative is the feeling of foulness, closeness, or stuffiness of the atmosphere, which becomes intolerable to the inmates. But before this stage is reached the inmates have lost a large measure of their sensitiveness to the offensive character of the atmosphere, which one entering directly from the outer air recognises readily as decidedly disagreeable. Breathing this atmosphere for long periods is highly injurious, and is one of the factors very largely responsible for producing the condition of lung and of the general system which constitute the fitting soil for consumption. The air of a room from which the respiratory products are not duly and effectively removed as they are produced becomes laden with carbon dioxide, becomes deficient in oxygen, and contains large amounts of organic exhalations from the lungs, the skin, and the clothing of the inmates. This air is deficient in nutritive power

of oxygen. It is poisonous through its carbon dioxide and its organic matter. It produces dulness, somnolence, and faintness, if the impurities be in great excess, as is frequently seen in churches and halls.

In the ordinary respiratory process the air is carried into the larger tubes in currents by the rising of the chest walls and the sinking of the diaphragm. Into the finer tubes and the air cells this current barely reaches, and the changes which take place here are mainly those of diffusion. And the rate of diffusion depends on the tension of the several gases in the mixtures brought together. So that if the air drawn into the larger tubes contains a greater per centage of carbonic acid than normal, the diffusion of carbonic acid from the air cells into the tubes is rendered less active—less carbonic acid is exhaled in a given time. That means less depuration of the blood, and less oxygenation of the tissues.

In some experiments which I performed on the effects on the respiratory functions of breathing prebreathed air, I found that breathing pure air, containing about 6 parts of carbon dioxide per 10,000, the exhaled air contained about 4·1 per cent.; and while the pure air contained about 20 per cent. of oxygen, the expired air contained about 17·5 per cent. These are the ordinary proportions in expired air. I now rebreathed this same air (from a bag into which I had exhaled it), and again tested it. It now contained 5·6 per cent. This again I breathed, and again tested. It now contained 6·3 per cent. That is to say, that when pure air was breathed, 4·1 per cent. of carbonic acid was given out. When this impure air was breathed, only 1·5 per cent. was given out by the respiratory act. And when this still more impure air was breathed, only ·7 per cent. was given off. This, of course, was very excessive impurity, but it shows, though in an excessive degree, the nature of the action of impure air on the function of respiration. The excessive tension of carbon dioxide in the very impure air rendered the diffusion of carbon dioxide defective, and probably the narcotic and poisonous action of the respiratory products on the lungs themselves lessened the intensity of the vital function. It is impossible to breathe impure air without having waste products retained in the system and some direct injury done by the poisonous materials.

We are apt to forget that air is food. We breathe daily 40 to 50 pounds of air. As Wanklyn says, "it is hardly an exaggeration to say that our aërial food, which enters by way of the lungs,

dwarfs our liquid and solid food into insignificance." And when one considers that the impurities (minute stated as per centages, but large in total amount) are poisonous, it becomes evident that we have a serious source of danger to health. About 30 ounces of oxygen are absorbed into the blood per day from the air inspired. This is true food, and is absolutely essential to life. A few minutes' deprivation of it means death.

This century has, through the scourge of cholera, learned of the importance of a pure water supply—of the terrible dangers arising from a slight contamination of water with organic impurities. At great cost, it has to a wonderful extent met the requirements of communities in this matter. The importance of purity of food has also been recognised, and its correlative the danger of impurity and adulteration, and much has been done to secure safety in this direction. The importance of drainage and the danger of bad systems and of bad workmanship have been recognised, and great improvement has taken place in these matters. But not much has yet been done in the way of securing purity of our aërial food. We refuse to drink water which may contain even minute traces of excrementitious matter, but we breathe air which is laden with the excrements of our lungs and skins, and with other organic refuse. This we do in our houses and workshops, our schools, halls, churches, theatres. Wherever an impure atmosphere is habitually breathed, in special trades or in special localities, there you find a prevalence of consumption; and in Glasgow it may be said that the prevalence of consumption is inversely as the cubic space occupied in the houses per head. Surely the time has come for an advance towards more healthy conditions—towards a better appreciation of the value of pure air and the means to secure it. Much in this direction must be done by medical men spreading knowledge—much must be done by sanitary departments insisting on proper ventilation being secured; but, meantime, most can be done by architects, who have to a large extent the practical solution in their hands.

Cholera has proved one of the greatest blessings of this century, inasmuch as it has enforced the necessity for a pure water supply. It has thus, by general improvement of health, saved vastly more lives than it destroyed. Consumption should now teach us the need of pure air, and so ultimately produce a general improvement in health as a counterpart to its present ravages.

But how is purity of atmosphere to be maintained? What

system of ventilation is to be adopted? It is necessary that a sufficient area be provided for each individual occupying a room. This is an essential condition of ventilation, so as to permit of sufficient change of air without appreciable current. But large space without efficient means of renewing the atmosphere will not suffice. The more space the longer will it take to render the air impure, but impure it undoubtedly will become if not renewed. Fresh air to the extent of something like 3,000 cubic feet must be supplied per hour for each individual, if a reasonably healthy condition is to be maintained.

It may be said that any system is better than none. For ventilation there are required inlets for fresh air, outlets for impure air, and some force to cause these to be operative.

The inlets very frequently relied upon are, as already said, chinks at doors and windows, in the flooring, and in the belting. Frequently, in addition to these, the soil-pipe, if there be any perforations in it, or if there be a loose joint, supplies a not inconsiderable portion of the atmosphere of a house. The only outlet usually provided is the chimney. The only force usually employed is the heat of the air in the chimney when a fire is burning, or the heat of the room when there is no fire. Winds, when they happen to be blowing, assist by getting in at chinks, and perhaps by aiding the action of the chimney as an extractor. Diffusion of air acts freely at chinks and through thin layers of wood and of plaster, but this diffusion aids only in the removal of the gaseous impurities, such as carbon dioxide, and does not materially assist in the removal of organic matter and of microbes.

The difficulty in the way of providing sufficient inlets is the fear of producing draughts. The dread of draughts is due largely to the fact that people are not sufficiently accustomed to the flow of pure air. And, after all, draughts are less hurtful, although at the moment perhaps more disagreeable than foul air. The word draught is Anglo-Saxon, and simply means drawing. Two conditions determine the character of a draught—first the rate at which it is drawn, and secondly the temperature at which it strikes us. Nobody complains of a draught in the open air, and those who live much in the open air are less subject to colds and consumption than those who live in close atmospheres. If a fire is burning in a room a certain amount of air is carried up the chimney, and this must be supplied by inlets of air of some kind. The smaller the inlet the more rapidly must the required amount

retained to warm the place. This is the worst of all forms of heating.

No church, school, hall, or theatre should be allowed to be built without some mechanical arrangement for ventilation being provided. No ventilation without the use of mechanical power is at all adequate for the ventilation of buildings in which many people are congregated, and it is to be hoped that ere long, when electrical or other power comes to be more generally distributed, it may be possible, even in small houses, to have ventilating fanners worked, so as to provide for the due ventilation of houses individually or in blocks. This may seem fanciful and over-strained, but all advances are apt, when first looked at, to be so considered, as was the proposal to pass gas through pipes for lighting cities. And it must be remembered all previous hygienic advances have been similarly viewed. It is not so long since this country learned the dangers of impurity of water supply, and gave up the use of filthy wells and impure streams for the general supply of water for domestic purposes. The last generation had no clear conception of the need of pure water, and clung to the old wells with tenacity. Over large parts of the Continent of Europe the idea of the necessity of purity of water supply has made little headway, and our scrupulous care in this matter seems to these people to be ridiculous. We should now learn and should apply the same lessons to air, and it is to be hoped, and indeed expected, that the next generation, if not this one, will come to look upon impure air with as much horror as we now look upon impure water. But until mechanical power is readily available for this purpose, we must be content to use the means at present to hand. The amount of air necessary to maintain at least moderate purity of atmosphere should be admitted to every occupied room somehow, and better anyhow than not at all.

A large responsibility rests with architects in this matter of ventilation, and it is to be earnestly hoped that they will make their knowledge operative in producing improved conditions of ventilation.

As to the heating of the house not much need be said. We all like the open fire, and its usefulness as a ventilating agent recommends it. It is of course not an economical mode of heating. Heating pipes—water or steam—can be made more readily to heat the whole house, and, when carefully regulated, and made to contribute to the ventilation, are undoubtedly to be

recommended as healthy. All appliances which burn in a house without direct connection with a flue for carrying off the products of combustion are objectionable. Iron stoves unduly dry the air, and also give off a certain amount of carbonic monoxide—a very strong poison,—and are not so wholesome as open fires.

The worst of all modes of heating a room is by keeping it so closed up that it gains heat from the inmates, because this means defective ventilation, it means the accumulation of heated lung and skin exhalations. Such air is foul and is always found to contain large numbers of microbes.

The lighting of a house has an important relation to health. A large inflow of sunlight to a house is decidedly favourable to health. In a city it is not easy to secure this to the extent to be desired, and, as a rule, the only way in which any material improvement in this matter can be made is by increasing the width of the streets in proportion to the height of the buildings, and by providing more windows and larger ones. The objection to more glass in the house construction is that it makes the rooms colder, but, if necessary, this objection can be met by making the windows of two layers of glass with an air space between. Sunlight is nature's most perfect purifier—it vitalizes the higher forms of life and destroys the lower forms. Microbes of putrefaction and of disease—even the bacillus of tubercle—are killed by a few hours' exposure to sunlight and air. Oxidation is rendered more active by sunlight, and so chemical impurities are more speedily destroyed. Putrefaction and fermentation, when they take place in sunlight, are less dangerous than in gloom, because the intermediate products, which are the more harmful, are speedily converted into the ultimate products, which are innocuous. The effects of sunlight on vital processes is most easily seen by its action on plants. Its effects on human life are not so directly apparent, but note the difference produced on a town-living child by a day's outing in the fresh air and sunlight of the country—on his complexion, his appetite, his vigour, his spirits. We require in our cities more open spaces and wider streets, and we require houses so situated and so constructed as to admit a large amount of sunlight and air. We require more of the conditions of life and fewer than we now have of the conditions tending to death.

As to artificial lighting, it may be said that all lights produced by combustion use up oxygen; and they give off products such as carbon dioxide when the combustion is complete, and the more

poisonous carbon monoxide when the combustion is imperfect. Other products in small quantities escape. Each gas jet may be said as a rule to contribute as much to the impurity of a room as three persons. In calculating the amount of air required this must be taken into account. The gas should be as completely burned as possible, using good burners, frequently renewed. Special burners, such as Argand and Siemens, are good. The same may be said as to the incandescent mantle. But it is unfortunate that in our ordinary modes of lighting the products are permitted to enter the air of the room. It would be a great advantage to lead the gases produced, by tubes, into a chimney or directly into the outer air, at the same time making use of the heat of the outgoing gases as motive power for ventilation, as is done in the Wenham light. The ventilating power of the heated products of gas combustion are too valuable to be lost, and in default of other power should be generally made use of. Electric light, somewhat shaded to protect the eyes, is certainly more healthy than gas light, but it cannot be made to contribute in the same way to ventilation.

Finally, cleanliness of the house is essential to healthy conditions. The dust and dirt which collect on shelves, on rough walls, in corners and in chinks, contain a large amount of organic matter and microbes. The house should have as few dark corners as possible, the walls and ceiling should be so painted or papered as to present as little as possible of rough surface for retention of dust, and so as to permit of being very readily cleaned. Abundance of light renders such dust obtrusively visible and induces the housewife to remove it. Sunlight and air destroy the hurtful properties of the organic material in the dust and render it harmless.

In dealing with the questions now brought before you, it has not been forgotten that the health aspects of them only, lay within the scope of this paper. The general principles only have been considered. The methods of applying them are for the consideration of the engineer, the builder, and the architect. What is wanted first is that the conditions of health in a house should be clearly apprehended, and that the necessity for supplying these conditions should be fully appreciated.

Glasgow architects, builders, and engineers, have for long been in sanitary matters, amongst the pioneers of improvement, and in the matters which have now been brought before you, it can hardly be doubted, that they will not wait till others lead them.

X.—*Sugar Bounties.* By JAMES R. GREIG.

(A Communication from the Economic Science Section.)

[Read before the Society, 3rd March, 1897.]

A GREAT amount of attention has of late been drawn to the question of Continental Sugar Bounties, and to the seriousness of their effects upon our West Indian Colonies and other cane-sugar producing countries and industries.

I have been asked to read you a paper on this subject; but, while it is of deep and vital interest to all directly concerned, I fear the facts are somewhat dry, and there is little new to tell. The question is still in solution, and the time has not yet arrived when feelings and passions will be stirred by tales of suffering and disaster, or of victory for the honest toil and labour of our brothers in the Colonies.

I learn that about the year 1887 a paper on the Sugar Bounties was read before the members of this Society by Mr. William Wilson, of Messrs. W. Connal & Co., and I understand that he reviewed the whole system of continental bounties up to that time. Professor Smart founded a pamphlet on that lecture, which he published, and between them they pretty well exhausted all that could be said on the subject at that period.

They told how, as early as 1747, a Prussian chemist had discovered that sugar could be extracted from the white Silesian beetroot, and, after many experiments, that a factory for the production of sugar had been established in Prussia in 1776. During the constant wars at the end of last and beginning of this century, when the French ports were generally blockaded, the first Napoleon studied and encouraged the production of sugar from this source for the supply of France.

When peace supervened, and cane sugar could be brought from the tropics, the manufacture languished, and little was known of it in this country, but it was always kept up for supply of the inland parts of Europe.

About 1855, during the Crimean War, there happened to be a very short supply of sugar in England, and prices rose as high as 64s. for muscovado sugar in the Glasgow market, and, I may mention, the freight from West Indies was £5 per ton, and the duty 14s. per cwt. at same time. Other sources of supply were sought, and beet sugar was then first brought to this country.

High prices did not continue for many months; but this new supply of sugar had been discovered, and, unfortunately for themselves, our refiners encouraged the importation, so as to keep cane sugar in check.

Before long it was regularly imported, and by 1860 was reckoned upon in the sugar statistics, and the production of beet sugar on the Continent in 1861 was 400,000 tons—

146,000	tons being grown	in	France.
125,000	„	„	Germany.
55,000	„	„	Austria.
74,000	„	„	Holland and Belgium.
400,000			

Before 1860 much attention had been paid to the cultivation of this root. When simply used for feeding of cattle, quantity was all that was desired, but when sugar was the primary object a different system had to be followed. It was found that deep tillage and subsoil ploughing gave the best sugar results; heavy manuring and special selection of seed were required; therefore, mutual arrangements between farmers and fabricants had to be carried out with this end in view. It became a rotation crop, and grain crops following were found to have been vastly benefited from previous high cultivation.

Thus, in the northern provinces of France, which formerly were the poorest districts, only growing meagre crops of wheat and flax, &c., they now raised a crop of sugar of more value on a portion of the land, larger grain crops than before on another portion, and the refuse pulp from the beets supplied food for cattle; so that, roughly speaking, three times the value was taken from the land.

At same time, as beet in its cultivation and manufacture requires much labour, of women and children as well as of men, employment was found for a large population. Large quantities of machinery were required for implements and for the manufacture of sugar. Manures had to be imported and fuel brought to

the *fabriks*, which grew up everywhere. Railways and roads for conveyance of roots and sugar, &c., had to be constructed. We thus find towns and villages have grown into the most important and busiest cities and ports in France, and these northern provinces have become the richest and most populous.

In Germany, Austria, and wherever the beet is grown, the same tale is told—poor provinces have become rich, population and employment have vastly increased, engineering and mechanical establishments started and kept in work, and railways and ports built up. Indeed, when we compare the Continent of thirty to forty years ago with the Continent of to-day, we are astonished to find how much of the new energy and life is concentrated in the districts where beet sugar is produced, and how much of it originated in and from this production; and, sad to say, the whole of this prosperity has been built up under protection and bounties.

In the earlier years of beet sugar manufacture, so long as the production of each country did not exceed its home consumption, bounties were not thought of; but when production exceeded consumption, the surplus had to be exported. Probably it was not intended to give a bounty by any of the countries, but it emerged, almost unintentionally, about the year 1860 in Austria.

In Austria, as in the other continental countries, a customs duty was exacted for purposes of protection against all foreign sugars coming into the country, and an excise duty for revenue purposes on all sugars made in the country—the effect of these duties being that Austria paid dear for sugar consumed at home. Before 1860 this protection had done its work, the import of sugar had ceased, and the home grower had the market to himself. But an enormous stimulus had been given to the growing of beet; factories started everywhere; and when production outran the home demand, the surplus had to be exported, and the Government had to repay to the exporter, in the shape of a drawback, the excise duties which had been exacted and made the article artificially dear.

This is all very well so long as the drawback is simply equivalent to the duty, but it was soon found that Austrian sugars began to pour into our market, underselling all other sugars. The reason was not far to seek. The drawback was greater than the duty, and thus a direct inducement was given to every maker of beetroot sugar to produce for export as much as possible. The way this was

brought about was thus:—the duty was assessed upon the estimated output or production of each *fabrik* separately, an inspector visited each works, calculated its efficiency, and the duty was imposed on this amount. Therefore everything the fabricant could produce above that estimate was free of duty and could be sold at home for the duty-paid price, or, if exported, got the drawback.

This loose system might suit a limited manufacture; but as crops grew, which they did rapidly, from 55,000 tons in 1861 to 500,000 tons in 1879, the absurdity became very apparent, and in 1876 crop, all the duty, amounting to five million guldens, was returned as drawbacks to the exporters, and a balance in addition from the Treasury. This was too much for even a protective continental country, and a Bill was passed in 1878 that the Government must get a minimum revenue of six million guldens from sugar duties each year, to be made up from the next if necessary.

That a large bounty was still made by the fabricants is shown by the steady increase of the crop, which this year is estimated to yield 1,000,000 tons of sugar, and the bounty to be received by the exporter is estimated at over £2 per ton. Other countries, seeing what was being done in Austria, were not slow to follow her example, and, while their systems of assessing duties were different, the same results followed.

In Germany the excise duty was assessed on the weight of roots delivered into the *fabrik* without regard to saccharine quality. The fabricants at once saw it to be for their interest to demand richer roots from the farmers. They brought scientific experiment to bear on the subject, and, by careful selection of seed and high cultivation, soon made vast advances in the yield of sugar obtained from the roots.

The drawback was calculated upon a return of 8¾ per cent. of saccharine matter from the roots; and so long as returns continued at this percentage no bounty was got, but gradually the return increased, till for the past ten years the average of the whole production of the country has risen to about 12 per cent. Thus, if 100 tons roots go into a *fabrik* paying 16 marks excise duty, say £80, if these 100 tons yielded 8¾ per cent. of sugar, the export drawback would be £79, but if they yielded 12 per cent. of sugar, the drawback would be £108, so that the exporter got a bounty of £28 on every 100 tons of roots.

This system continued till August, 1892; but the burden had then become so onerous to the Treasury that the Reichstag altered the method of taxation, charging a duty on home consumption of sugar, and granting a direct bounty on export of 7½d. per cwt. on raw sugars.

Germany made the most rapid strides of all the countries under her previous bounties, and while we saw her crop was—

In	1861	.	125,000 tons,
,,	1875	it was	300,000 ,,
,,	1887	,,	1,000,000 ,,
,,	1894 and 96	,,	1,950,000 ,,

The reduction in the bounties of 1892 does not seem to have affected her production, as we see from the foregoing crops that it has steadily increased; but this enormous increase has brought about such low prices that, instead of reducing bounties, as was intended by the law of 1892, the importance of the trade and fear of consequences to growers has compelled the Government to double the export bounty to 1s. 3d. per cwt. for raws.

In France no bounty was paid on raw beet sugar before 1884, as the *fabriks* were worked under bond, and duty was only paid on the produce going into consumption, or into the refinery. By that year, however, France had fallen behind so much in production, and Germany was pouring her sugar into the country to such an extent that the Government passed a law prohibitive of raw beet sugar being imported, and changing their system of taxation to that in force in Germany. Thus, every 100 tons of roots were supposed to yield 6 tons of raw sugar, and an export drawback was given accordingly. The usual result followed, and now the average return is 10 to 11 per cent. of sugar. By 1887 the crop had risen to 500,000 tons, and this year it is close on 800,000 tons.

Holland, Belgium, and Russia were later in filling up their home markets, but all of them now export and grant large bounties. Holland charges a duty on the estimated density of the juice, and when made low enough a bounty is obtained. In Belgium the duty is assessed on the quantity of juice, and it is said by fabricants that the extent of the bounty depends on how much they can cheat the Government; at any rate, it is estimated at about £5 per ton, and crops have steadily increased from 14,000 tons in 1861 to 265,000 this past year.

and prices fell rapidly to as low a point as they had ever touched, and vast sums of money were lost by speculators and all holders of sugar.

During the past ten years a system of speculation or gambling has emerged in beet sugar, with regular exchanges, similar to the Stock Exchange, in which beet sugar can be bought and sold on time bargains and forward contracts to any extent. This has led to the usual evils, and has had a disastrous effect on the markets.

We thus see sugar being produced on the Continent in large and larger quantities, far above the normal consumption of the various countries, under a system of bounties through which they pay £5,000,000 or £6,000,000 per annum on their exports. Prices are forced down in countries of import below the cost of production, even with bounties added, though growers may recoup themselves from their home consumers to a large extent, and we thus see the anomaly of retail prices *here* being 1d. to 2d. per lb., while in countries of production it is 3d. to 7d. per lb.

Formerly the competition was between continental producers for possession of our markets, but of late it has become a fight of beet *versus* cane sugar.

Producers of cane sugar in the far East, such as the Philippine Islands and Java, work under extremely low wages, and have neighbouring markets for a portion of their sugars. Mauritius had the Indian and Australian markets, though even in India beet is being largely introduced, and Queensland is protected by £5 per ton duty.

Louisiana and the Sandwich Islands are protected by the American duty of about £4 per ton at present, but this is expected to be raised shortly to about £7 per ton.

Cuba for the present is out of the contest, owing to the revolution, but if they get peace it will probably be through the intervention of the United States, and the result will be a reciprocity treaty, by which Cuba will get her sugar imported into the United States free from duty. We thus see our British West India Colonies have had to bear the whole effects of this contest without help, and are powerless to act for themselves, and their history in this respect has been a sad one.

The sugar cane, unlike the beet, is not an annual plant but takes from 12 to 15 months to reach maturity. After the canes are cut, sprouts from the roots or cane stools, spring up and are cut again next year, and it may be for several following years,

giving, however, a reducing return each year, till it is dug out and the land is replanted.

Vegetation is so rapid in the tropics that the cane fields require to be weeded several times until the canes grow up; and drainage is required during wet seasons. As cane is not a rotation crop, but continues from year to year, the ground ultimately becomes exhausted of some of its constituents, and these have to be returned in the shape of suitable manures.

It follows, therefore, that cane is a more expensive crop to grow than beet, and were it not that 50 to 100 per cent. more weight of cane can be got per acre, could not compete with beet.

After 1837, when slavery was abolished, the production of the West Indies sunk to a minimum, as the freed slaves could not be got to work regularly.

After a time the negroes in the smaller, and at that time more populous islands of the Lesser Antilles, had to work, as there was no spare land for them to squat upon. So they gradually settled upon the estates, and the sugar industry revived and was continued on the old lines and the same old system of manufacture of muscovado sugars.

Prior to the year 1884 the incidence of taxation in the United States was more favourable to these low sugars, and, as our United Kingdom refiners turned more and more to beet, these sugars were sent to the United States, till that became almost the sole market for muscovadoes. As prices fell, profits and wages were reduced, and since 1891, when they experienced the full competition of beet sugar in America, they have suffered serious losses. Estates went out of cultivation, and many of the islands with smaller populations ceased producing sugar altogether.

Only Barbadoes, St. Kitts, and Antigua continue the contest, having denser populations, but wages are reduced to 4½d. and 6d. per day, and the losses to planters are such that preliminary orders have been given in many cases that estates must shortly be abandoned.

In Demerara and Trinidad things took a different course. There were few slaves and ample forest land in these Colonies. Nothing could be done with negroes after emancipation, but the planters were principally Scotch and Irish, and now after the first blow they set to work to see what could be done, and by 1844 they started immigration of coolies from India. This progressed at first under difficulties, official and otherwise, and even Chinese

immigration was tried; but ultimately these difficulties were overcome, and up till now many hundred thousand coolies from India have been introduced, much to their own advantage and to that of these two Colonies. They are indentured for five years at a minimum wage of 25 cents per day of 9 hours, and at the end of ten years they get a free return passage. Only about 10 per cent. really do go back, and these carry away with them an average of about £70 in remittances, in addition to all the coin and bullion-jewellery on their persons. Those who choose to remain get a grant of ten acres of land, upon which they can settle. During the whole time of indenture they are under the supervision of a Government department as regards housing, hospitals, medicine, and medical attendance, all of which are provided by the estates, and coolie labourers bear favourable comparison with the agricultural labourers in this country.

The same energy which provided the labourers at the same time improved the cultivation and manufacture of the sugar cane, and as competition of beet increased, so did the means employed to overcome it—more intense cultivation and manuring of the cane field, so as to get a larger return per acre, better roads and canals or tramways to bring the canes to the mills, and give means of transport, and the most modern machinery and modes of manufacture were employed. The small estates' proprietors, who could not provide the means for improvements, had to sell out, and the estates concentrated into larger blocks, with a central factory to manufacture for the whole, so that where at one time 200 to 300 tons was a large estate (and is so now in Barbadoes and St. Kitts, &c.), 2,000 to 3,000 tons is common, and from 5,000 up to 10,000 tons is the amount aimed at. As may be supposed, such estates, cutting, bringing into the mill, crushing, and manufacturing 600 to 700 tons of canes into 60 to 70 tons sugar per day, for six days every week, for from 12 to 15 weeks straight on end, require a manager thoroughly educated and acquainted with his work, and having under him cultivating and manufacturing managers, chemists, and engineers of first-class ability; and anyone seeing a first-class estate of many thousand acres in cultivation, and many miles in extent, with a ramification of railways and locomotives, and manufactory covering many acres, crowded with machinery, will never again talk of antiquated methods, for few sights can be had in this country of such a busy scene of energy and labour well directed to one end.

The result has been that, whereas twenty years ago the cost of production in these two Colonies was £18 to £20 per ton, it has now been reduced to from £10 to £12 per ton, without calculating interest or depreciation, but the net return is from £9 to £10. This cannot continue for long, and would have come to a disastrous end long ago, but it must be understood that in the tropics there are no half measures. Abandonment means a total loss of all capital ever sunk in estates, for if it does not pay the present proprietors to work them, no one can take their place, and in a few months weeds and bush cover everything, and ruin is complete.

The effect of abandonment upon the Colonies and population would be crushing. For a generation the people have been in steady employment and earning good wages, and for these suddenly to cease will be a serious matter. Many of the coolies in Demerara and Trinidad could be sent back to India at a considerable cost to the Colonies, but still the great bulk of the population would be helpless. As an instance, in October last orders were sent out to a large Demerara property that the cost must be reduced to £10 per ton, and towards this result the wages of the free labourers should be reduced. Intimation that some 500 of such labourers would be reduced 5 cents. per day was posted on the gates; these men so affected struck work and induced the indentured gangs to join them, about 2,000 people came into the works to appeal or protest. Now the bulk of the estate labourers carry a stick or cutlass in their hands, so the manager, fearing trouble, sent to town for some policemen. These came out, but the crowd appeared threatening, and when ordered to go to barracks or to their houses they refused, and the upshot was the police had to fire on them. Some eight were killed and sixty to seventy wounded. This quelled the riot. These men were coolies. But in St. Kitts, last year, there was more than one riot of the negroes, with incendiary fires, and some man-of-war's men had to be landed, and several men were shot.

The white people on the estates and in the country are not a tenth of the population, and if there was general abandonment and cessation of wages, those who know the islands best fear there would be risings among the labourers, and, when the hopelessness of the situation came to be appreciated, every man would seize what he could, and this would lead to rioting and incendiarism.

Of late years the policy of the Government has been to withdraw troops from all the islands, except St. Lucia (although there are

still a few in Barbadoes till they also can be removed), and volunteer companies of infantry in town and yeomanry in the country districts have been formed to replace them for local protection. In the country these yeomanry are entirely composed of the whites on the estates, but abandonment of the estates means discharge from employment of all these men, and it is rather too much to expect that they will stay and protect estates and property. Under these conditions they are more likely to leave the district and come into the towns, preparatory to leaving the Colonies, and, without restraint, in want, and starving, there is no saying to what excess the poor labourers may be driven.

It seems hard to believe such things could happen at this time of day after such a long period of peace, but no one who knows the circumstances doubts that they are most likely to occur. The negroes and coolies are antagonistic as a rule, and this is our safety; but common distress will lead to common aims, and the negroes will be too glad to raise trouble between the coolies and the Government. This has happened before, and we may reckon on it again. There has been since the independence of Hayti and St. Domingo, an aspiration among the negro population of at some time ousting the whites, and gaining the West Indies for the blacks, and among the coloured population of getting governing control; and this is the primary cause of the Cuban revolution, so that abandonment of the estates would be equivalent to withdrawing the white garrison which prevents this, and revolutionary leaders would at once arise and raise the cry of independence. Then the sight may yet be seen of England reconquering these islands at the end of the nineteenth century, as in the case of the Indian mutiny or the late rising in Rhodesia.

I have tried to state the present condition of our West Indian Colonies, and the cause of it. The position has been constantly kept before the Government of this country, several committees have examined into it, and at least three conventions have met and reported upon the question. Curiously enough, the findings were always to the same effect—"That the bounties were an evil, contrary to our Free Trade principles, and should be abolished, and were ruining our refining trade and Colonies," but the results have always been the same—*nil*. The several conventions all aimed at abolishing the bounties by refining in bond, &c., but clearly saw that without a penalising clause all would be without avail. The convention of 1888 made the penalty a

prohibition of imports from any country granting a bounty. This was too drastic, and might have demoralised the markets, but probably it would never have been needed. Towards the end of last year the usual appeal was made to Government, and imminence of danger shown. We happened to have Mr. Chamberlain in power, a Colonial Secretary of a different stamp than usual. He inquired into the matter at once, and could get the advice of several Colonial Governors who happened to be at home. A Royal Commission to inquire into the position of the West Indies was appointed. They promptly set to work, called upon proprietors at home to state their case, and, after hearing this evidence, sailed for the West Indies on 13th January, where they are now, and their first evidence, taken in Demerara, appeared in *Glasgow Herald* on 19th February. They will visit all the sugar-producing Colonies, taking evidence in each, and come home about May, *via* New York. The Government will be guided by their report, but *the root of the evil lies on this side.* The labourers are paid their wages, and this money (as much as, or even more than hitherto) circulates. So all looks prosperous out there. If the Commissioners report—"We visited the West Indies, and found all well and prosperous," and nothing is, therefore, done, *the fiat will go forth from this side to abandon the estates, and chaos will reign supreme.* I think this is known in the Colonial Office, and they feel themselves on the horns of a dilemma, and it will take wise heads and strong minds to guide us out of the difficulty.

I think it must be obvious that the direct cause of all these evils arises from the continental bounties alone, by their encouraging over-production, and thus leading to lower prices in countries that receive these exports. If these countries of production consumed anything like the quantity of sugar used by America or Great Britain, all would be well, but, while the consumption—

Of Great Britain is	some	82 lbs.	per head	of population, that
,, America	,,	63	,,	,,
in France it is	,,	26	,,	,,
,, Germany ,,	,,	28	,,	,,
,, Austria ,,	,,	18	,,	,,
,, Russia ,,	,,	10	,,	,,

—this great difference being caused by the high duties exacted, and consequent high cost of sugar. It does seem monstrous that these

countries should pay such a price to give us cheap sugar; but they seem quite satisfied that the benefits they receive from increased agricultural development and all subsidiary industries quite compensate for all this. We suffer from this to an equal degree that they benefit, for if our production of sugar ceases, we will have on our hands the ruined West Indian Islands, and loss of all trade and commerce with them, and the transfer of all our home industries in connection with them. As was well pointed out by an engineer lately, that the loss of all our practical knowledge of sugar-making and refining machinery, and supply of the same, will tend more and more to drive away all these trades and employés in them from our shores. Another point that may just be mentioned is, that our agriculturists have been suffering for many years past, and it is known that *our country is as well adapted as many parts of the Continent for growing sugar beet,* and, in connection with cattle-feeding, would prosper, but, owing to bounties, the industry could never be successfully started. Without doubt, were the bounties abolished, this industry would be tried, and probably do much good. *What our country has lost in this direction is food for serious thought.*

It is held on the other side that these abnormally low prices for sugar have built up and encouraged our jam and confectionery trades, and these have taken possession of the world's markets, and employed more people than sugar refining and attendant trades ever did. The answer to this is, that at present, prices are many shillings below the average price upon which these trades began and have been accustomed to work, and they are protected by the duties of all other countries, which cannot get sugar under £5 to £10 higher cost. Also, if sugar did go up a halfpenny per lb., this would not be a farthing per lb. on the cost of these productions, and this would simply increase price so much.

I think the sympathies of most people are with us in our desire to get rid of these bounties, but the one great objection from the first has been the fear that anything done to counteract or remedy the evils arising from them might in some way go contrary to the principles of Free Trade. Had this system of bounties been known when the battle of Free Trade was fought, I have no doubt Mr. Cobden would have condemned them, as Mr. Gladstone, and, personally, the leaders of Free Trade now do. But Free Traders of this generation have accepted some of the axioms, such as "buying in the cheapest and selling in the dearest markets," &c.,

without considering the final consequences, and are prepared to see every trade but their own ruined rather than risk any change, even though justice and mercy call for it.

I have been fortunate enough to read Professor Smart's pamphlet on the subject, and it gives the "pros" and "cons" in the year 1887 so clearly that everyone should study it. He has chapters on "Ought anything to be Done," and "Something ought to be Done," &c., and comes to the conclusion that, in the interest of the community as a whole, bounties should be abolished. He thought at that time they should be abolished by convention, but the convention was held and came to nothing. He held that goods forced on us to the ruin of our industries might in the long run be disadvantageous to consumers, and every country had a right to protect itself. He did not approve of retaliation, but probably our Treasury simply collecting the bounty may not go under this name; he cannot suggest a definite remedy, but, seemingly, would like some power to step in and take action. Lately, in the French Senate, a statement was made "that bounties were doing more harm than good to continental countries, and should be abolished; but no country trusted another or would take the initiative. England held the key of the position in her own hands, and would help every one by putting a stop to them; and she could easily do so."

There have been many suggestions for remedying these evils, but, at present, these have almost been reduced to that of countervailing the bounty by charging a duty equal to the bounty, at port of import, on all sugars coming from a country granting bounties; and, so as to save our home refiners, this should probably be assessed on raw and refined separately, according to the bounty given. If such a law was passed, the probability is that every country would abandon its bounties, for the absurdity of paying a sum to its exporters to be at once handed to our Treasury would then strike them, though this is being done now in America to a trifling extent, and yet they continue doing so.

The average would come out between 2s. and 3s. per cwt., and such a duty would raise the price of sugar to that extent. The greatest benefit of this would be our cutting ourselves adrift from past ideas; for once it was seen that Britain was prepared to defend her industries, bounties and over-production of sugar would soon cease; and all other trades threatened could breathe freely, as, when assailed directly in the same way, there would be hope of relief also.

If the consumers paid more for their sugar, this would be returned in duty collected, but, to show that they get it directly returned, it has been suggested to take an equivalent duty off tea and coffee, so that to the consumer it would simply be paying dearer for sugar and cheaper for tea, and, while the incidence of taxation was changed, there would be no difference in principle. This would save our West Indian trade and help our refiners and all other industries connected with them, and also help our fellow Colonists, the tea producers in India and Ceylon.

In conclusion, we can only hope that the Royal Commission may be wisely guided, and bring home some hope of relief, and that our Government may be bold to act in a just cause.

XI.—*Sound and Speech Waves as revealed by the Phonograph, The Science Lecture for 1896.* By JOHN G. M'KENDRICK. M.D., LL.D., F.R.S., F.R.C.P.E., Professor of Physiology in the University of Glasgow.

[Delivered before the Society, 16th December, 1896.]

WHEN the Council did me the honour of inviting me to deliver the Science Lecture for 1896, I thought that I could not do better than endeavour to give you an account of a research in which I have been engaged during the last two years. This research relates to the interpretation of the marks on the wax cylinder of the phonograph, and it has an important bearing on certain questions connected with physiological acoustics. Perhaps I ought to apologise to the physicists for so far invading their territory in this research. The work, some of the results of which I shall place before you to-night, is, no doubt, mainly of a physical nature. But sciences dovetail into each other so as to render it impossible to draw a clear line of demarcation between those that are closely allied. Of this we have an example in the close relationship that exists between many departments of physiology and of physics. Take, for instance, the department we term physiological acoustics. The physicist deals with sound as consisting of certain movements of matter occurring outside the physiological organism, and he investigates these movements as dynamical problems. On the other hand, it is the business of the physiologist to show how these movements affect the mechanism of the sense organ, the ear, how the filaments of the auditory nerve are stimulated, and how the impulses transmitted by the nerve to the brain are there, in a way absolutely unknown at present, translated into consciousness. No physiologist can attempt to explain the mechanism of the ear without being acquainted with acoustics, nor can the physicist deal adequately with the phenomena of sound unless he takes into account the mechanism of the ear. Let me say to the physicists present that, if I have crossed into their territory in carrying out a purely physical research relating to hearing, I hope they will retaliate by pushing their researches into the physiological side, and apply their methods

to the investigation of the mechanical phenomena that end in a sensation of sound.

We have all more or less enjoyed, at one time or another of our lives, a certain amount of pleasure in the contemplation of wave movements. Rhythmic movement always gives pleasure, whether it be in the dance or in the undulations sweeping across a field of wheat when the winds of early summer are blowing. We have also, no doubt, stood on a rocky headland, or on the deck of an ocean steamer, and we have gazed with pleasure on the tumultuous action of the sea, as waves of many varying forms passed before our eyes. While the great rollers of the Atlantic have been distinctly visible, we have seen how their contours were moulded by numerous other waves, some possibly caused by the paddle-wheels or screws of passing vessels, by the eddies of wind that sweep over the surface of the water, or by the dip of a sea-bird's wing. While the infinite variety of form gave an abiding interest in the spectacle, the general feeling of rhythm probably contributed most to our feelings of pleasure.

The waves that we discuss in this lecture do not relate to movements that can be seen by the eye. Waves of sound appeal to the ear, not to the eye. They are invisible, and yet they are felt, because they excite variations of pressure on the drum-head of the ear; the effect of these variations is communicated to the nerve; the nerve carries the impulse to the brain, and we hear. Waves of sound differ in many respects from the waves which we see on the surface of water, and yet to explain sound waves we are often obliged to take our illustrations from the movements on the surface of water.

Let me, in the first place, lay before you a few general and elementary statements regarding waves of sound. A body that gives out sound is itself in movement.

The to-and-fro movements, say, of the limbs of a tuning fork, are called vibrations. These movements may be communicated to the air, or to liquids or solids. Let us confine our attention to the transmission of movements, vibrations, through the air, as it is by the medium of the air that we usually hear sounds. Each movement of the limb of the tuning fork causes first a greater pressure, and then, owing to the elasticity of the air, a smaller pressure on the air near it, and these variations of pressure are communicated through layer after layer of the air until they reach the drum-head of the ear. When there is an increase of pressure

on the drum-head it is pushed in, and when the pressure becomes less, the drum-head passes back to its first position. These variations of pressure, usually periodic in character, as they occur in the air, constitute sound waves. So far they are purely physical movements, and if we could see the air as it is traversed by sound waves we would see shells, as it were, of condensed air alternating with shells of rarified air—that is to say, the condensed portions would correspond to positions of greater pressure, while the rarified portions would represent the positions of smaller pressure. The positions of greater pressure correspond to the crests of waves on the surface of water, and those of smaller pressure to the trough between two adjacent waves. As you are aware, we determine the length of a wave by taking any point on its surface and measuring the distance to a corresponding point on the next succeeding wave. Thus we say the length of a wave is from crest to crest, or from trough to trough. In like manner we say that the length of a wave of sound is the distance of any point of condensation or of rarefaction to a corresponding point in the next wave.

Think, again, of waves on the surface of water. These may vary in length, or in amplitude, or in form, as is well shown by the diagram now thrown on the screen, from Mr. Sedley Taylor's interesting book on *Sound and Music*—

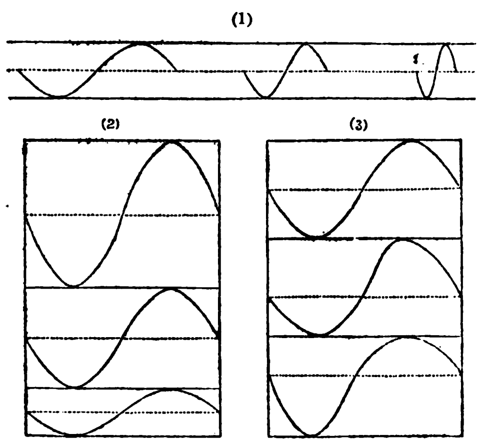

Fig. 1.—Waves.

Here you see, in (1) three waves the same in amplitude and form, but different in *length*; in (2) three waves the same in length and

form, but different in *amplitude*; and in (3) three waves the same in length and amplitude, but different in *form*. Thus we may have waves varying much in length from long rollers to those of a few inches in length; we may have waves with high crests and deep troughs, or they may be merely feeble ripples on the surface of the water; finally, the waves may vary much in form, some having a slanting ascent and a less slanting descent, or they may have flat crests and shallow crests, or the reverse. Thus there may be an almost infinite variety of wave forms, although they may not differ as to wave length and wave amplitude.

This illustration must now be applied to our conceptions of waves of sound. Thus a sounding body, such as a vibrating tuning fork, may cause waves, each of which is exactly similar to any one of the series, or to all the series. If we cause the tuning fork to record its vibrations on a moving surface, such as a drum moved with great regularity by clock work, and covered by paper blackened in a sooty flame, we obtain tracings like those now thrown on the screen:—

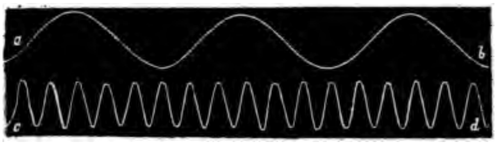

Fig. 2.—Tracings of the Vibrations of a Tuning Fork—10 vibrations per second. *a*, *b*, cylinder moving rapidly; *c*, *d*, cylinder moving slowly.*

These we may term simple waves, and they are caused by pendular vibrations—that is to say, by movements like the periodic oscillations of a pendulum. Apply this again to help out the conception of a wave of sound. The crests would correspond to the condensations, or greater pressures, and the troughs to the rarefactions, or lesser pressures.

From these simple waves we may now form compound waves. Thus I sound this large fork by drawing a fiddle bow across its prongs, and it gives out a strong, deep tone. This tone is caused by varying pressures on the drum-head, as I have explained. Then I sound this other fork, which gives out the octave of the first. It sets up a series of waves of half the length of those of the first, and the resultant tone is caused by a compound wave made up of

* M'Kendrick's "Physiology," Vol. I., Fig. 236, p. 385.

the two waves, the form of which (if the two waves started simultaneously) is shown in the diagram now on the screen :—

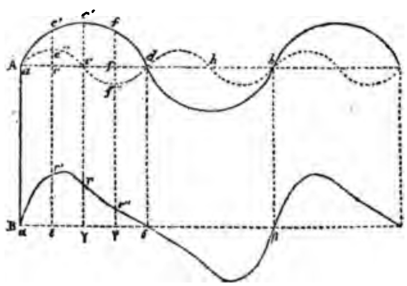

Fig. 3.—Formation of a Compound Wave, 1 : 2.

You observe that the lower wave is produced by combining the two upper waves. In like manner I now sound a fork which vibrates three times as fast as the first. The resultant tone now corresponds to a wave built up of two waves, as now shown on the screen :—

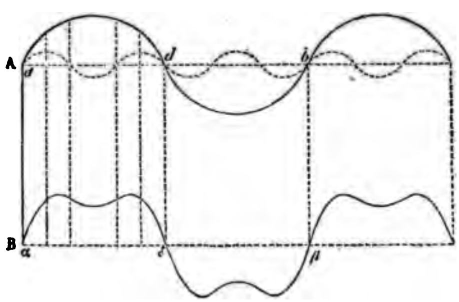

Fig. 4.—Formation of a Compound Wave, 1 : 3.

You observe the resultant wave produced by 1 : 3 is quite unlike that formed by 1 : 2. In this manner many wave forms may be produced. Thus you see in the next figure two simple waves represented by the thin lines, and the resultant wave form by the thick lines. In (1) and (2) the simple waves have the same length, but they differ in amplitude. Again, in (1) the troughs of the waves are on the same side of the dotted line which indicates the line of no variation of pressure, while in (2) the crest of the one wave is opposed to the trough of the other. In

both (1) and (2) the waves start at the same moment, but in (3) that is not the case.

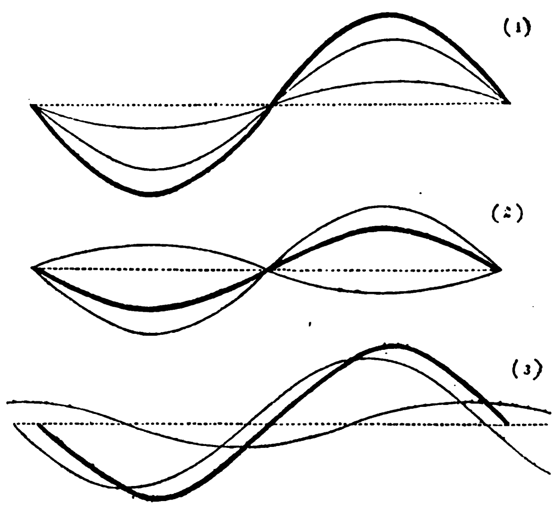

Fig. 5.—Resultant Wave Forms.

Suppose, again, two waves equal in amplitude started at the same moment, but so that the crest of the one corresponded to the trough of the other, it is evident the one would neutralise the other, and there would be no displacement. This is called the phenomenon of interference. Complete interference is shown in the next figure.

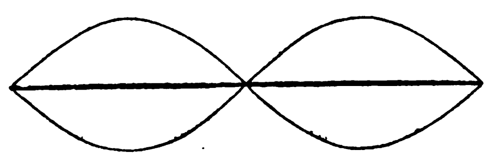

Fig. 6.—Interference.

The very complex form that may be produced by the combination of three waves is illustrated in the next figure. Here the wave 2 is the half of wave 1, and wave 3 is $1\frac{1}{2}$ that of 2, or wave 3 is the one-third of wave 1. In other words, the lengths of the waves are as 1, 2, and 3. The resultant wave form is seen in 4. The diagram also shows how the wave in 4 has been plotted out. Take the vertical line from *a′* in 1, 2, and 3, and measure in each case from the horizontal line to the top of the

curve. Add the three measurements, and the sum gives the point of the curve of 4 above b', and so on for any point on the curves of 1, 2, and 3. The measurements of the three lines, if above or below the horizontal lines, are added together, and the corresponding point is taken for curve 4; on the other hand, if one measurement be *above* the horizontal, and two or more be *below* the curve, then from the greater measurement the sum of the two smaller ones is taken, and the mean indicates the point on the curve 4.

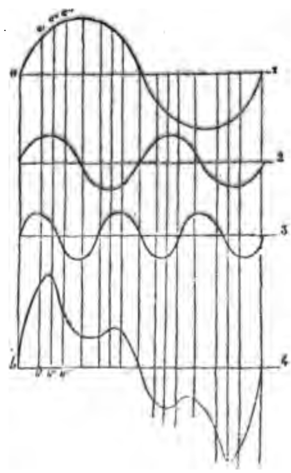

Fig. 7.—Superposition of Three Waves.

Another form of resultant wave is shown in the next figure. By combining A and B, C is produced.

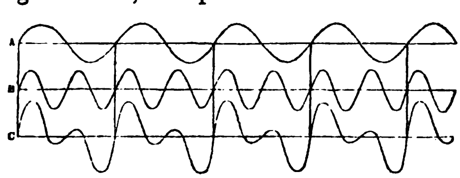

Fig. 8.—Compound Wave Form.

The form of the compound wave, however, will depend not only on the number and amplitude of the waves entering into its composition, but also on the relation of the phases of the vibrations of the constituent waves. Thus, if we start three waves at the same moment, we will obtain one resultant wave form; but we can vary

this by starting the waves at different times. This is well shown in a diagram from von Helmholtz, now on the screen :—

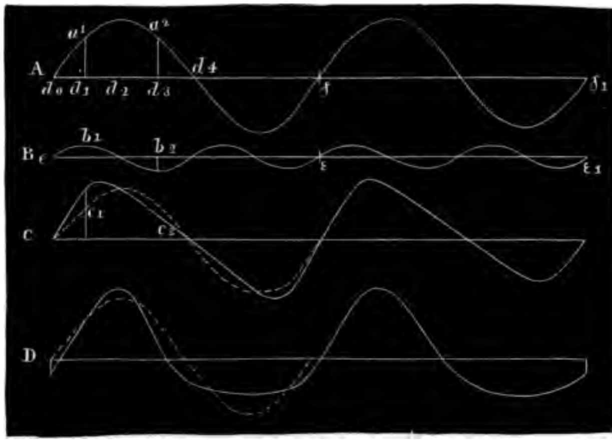

Fig. 9.—Waves, with Variation of Phase.

"If we superpose the two pendular vibrations A and B first with the point *e* of B on the point d_0 of A and next with the point *e* of B on the point d_1 of A, we obtain two entirely distinct vibrational curves C and D. By further displacement of the initial point *c*, so as to place it on d_2 or d_3, we obtain other forms." *

In this way a great variety of wave forms may result from combinations of two waves, as these differ in *length*, in *amplitude*, and in *phase*. Three such combinations are seen in the next figure, in which the thick line represents the resultant wave.

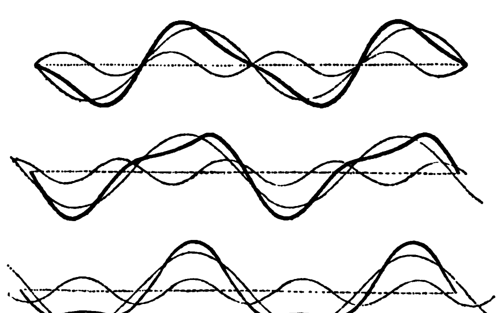

Fig. 10.—Compound Waves.

* von Helmholtz, *Sensations of Tone*, p. 174.

Thus we will now understand what is meant by a compound wave, and you will appreciate the statement that compound waves may be very complex in character. If you look at the curves showing the resultant waves, you will see that they represent, in a way, the character of the variations of pressure made on the drum-head. With simple pendular waves, as in Fig. 1, the drum-head moves out and in with perfect regularity, like the movements of a pendulum. The physiological effect of such simple pendular vibrations is a sensation of a pure tone, such as you hear when I bow this tuning fork. But if a compound wave falls on the drum-head, it is not so easy to follow with the imagination the variations of pressure. While these variations occur in regularly recurring intervals of time so as to give the sensation of the pitch of the fundamental tone, the movement may not be uniform on each side of the median line, indicating the position of repose of the drum-head, like the swing of a pendulum. Thus the drum-head may move in, owing to the increase of pressure, faster than it moves out, or the reverse; or it may move in a little distance, then return again to the starting point and again move in, and it may return to the position of rest after one or more to-and-fro movements. Again, it may be pushed in to the maximum distance, and remain in that position for a short time, and then return to the original place of repose. Thus the characters of the variations of pressure may vary to a remarkable degree—to a degree, with a very complex sound, that is to us almost inconceivable; but we may be sure that these variations of pressure will be faithfully followed by the drum-head, and communicated by it to the deeper ear. When a compound wave thus falls on the ear, the result is a sensation of sound of a certain quality, or timbre, or clang, and we say that we hear the sound of various musical instruments, as in a brass band or an orchestra, or the sound of a particular instrument, a trombone, a flute, a harp, a clarionet, or the sound of a well-known voice that we can distinguish from all others.

The attempt to record graphically the vibrations of bodies emitting sound has always been a fascinating occupation for physical observers. Thus it is easy, by the method suggested in 1807 by Thomas Young * and carried out by Wertheim † in

* TH. YOUNG. *A Course of Lectures on Natural Philosophy and the Mechanical Arts*, 1807, Vol. I., p. 191.

† G. WERTHEIM. *Recherches sur l'elasticité*, 1[er] mem.

1842, to obtain a record of the vibrations of a tuning fork, as shown in Fig. 1. Chronographs, such as you now see in operation, are found in every physical and physiological laboratory. Many attempts have been made to obtain tracings of the vibrations of membranes and of glass or metallic discs. In 1856, Léon Scott * invented the well-known phonautograph, an image of which is now thrown on the screen, and which may be regarded as the precursor of the phonograph.

Fig. 11.—The Phonautograph of Léon Scott.

The sounds are collected by the barrel-shaped part of the apparatus, and transmitted to a thin membrane to which a style is attached. The latter is brought against the blackened surface of the rotating drum, and a tracing of the vibrations is thus obtained. I throw on the screen a beautiful series of tracings taken by Dr. Koenig, Paris, by an instrument of this kind. (Fig. 12.)

Donders,† in 1870, applied the phonautograph to the investigation of the curves produced by the sounds of vowels. Next came the logograph of Barlow,‡ by which curves were obtained by the vibrations of a thin membrane of gold-beater's skin. These curves represented the varying pressures of the expelled air taken

* E. L. Scott, *Comptes rendus*, t. 53, p. 108.

† Donders. *De physiologie der spraachklanken in het bijzonder van die der nederlandische taal.* Utrecht, 1870.

‡ Barlow. *Trans. of Royal Society*, 1874.

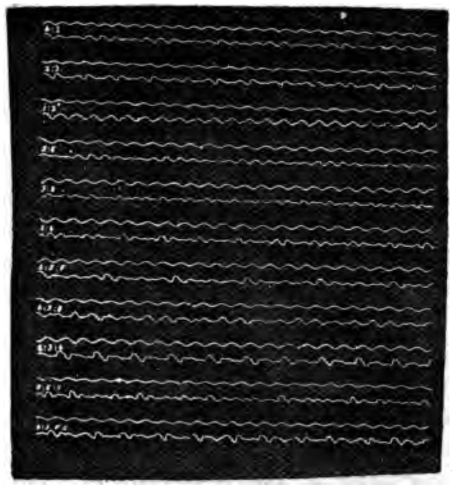

Fig. 12.—Vibrations of the Membrane of the Phonautograph under the influence of a series of organ pipes, the ratio of the vibrations of which are indicated by the figures. Above each tracing is a tracing of the vibrations of a tuning fork of 512 vibrations per second.

as a whole, but did not indicate pitch. About 1862, Koenig* introduced the method of manometric flames, and flame pictures of vibrations were thus obtained. In 1876, Clarence J. Blake† employed the human *membrana tympani* as a logograph. In the same year, Stein‡ carried out a method by which he photographed the vibrations of tuning forks, strings, &c., by attaching to them plates of blackened mica perforated by small holes. A beam of light passing through a hole was allowed to play on a sensitive photographic plate moving with uniform velocity. There was thus recorded a curve representing the combined motions. All of these instruments made it possible to record vibrations, but the sound could not be reproduced from the tracings thus obtained. This was accomplished by Edison when he invented the phonograph. In 1878, Fleeming Jenkin and Ewing§ succeeded in obtaining tracings of the

* RUDOLPH KOENIG. *Annalen der Poggendorff*, t. CXXII., pp. 242, 660. 1864. See also *Les Flammes Manométrique in Quelques Expériences d'Acoustique.* Paris, 1882.

† BLAKE, C. J. *Archiv. of Ophthalmology and Otology*, Vol. V., p. 1, 1876.

‡ STEIN, S. TH. *Die Photographie der Tone. Poggendorff's Annalen*, 1876, p. 142.

§ FLEEMING JENKIN and EWING. *On the Harmonic Analysis of certain Vowel Sounds. Trans. Roy. Soc. Ed.*, Vol. XXVIII., p. 145.

records of vowel sounds on the tinfoil phonograph, and the curves were submitted to harmonic analysis. Shortly afterwards, and in the same year, 1878, E. W. Blake* succeeded in photographing the minute vibrations of a circular ferrotype plate screwed to a telephone mouthpiece by attaching a small mirror to the back of the plate and directing a reflected beam of sunlight on a moving photographic plate. Since that time, the marks on the tinfoil of the first phonograph have been scrutinised by Grutzner, Mayer, Graham Bell, Preece, and Lahr.† The imperfections of the tinfoil phonograph made progress impossible for ten years (from 1878 to 1888), during which time, however, Edison, Graham Bell, and others were engaged in working out the mechanical details of the wax-cylinder phonograph. The subject was then taken up by Hermann,‡ and he succeeded in obtaining photographs of the vibrations of the vowel sounds, a beam of light reflected from a small mirror attached to the vibrating disc of the phonograph being allowed to fall on a sensitive plate while the phonograph was slowly travelling. The curves thus obtained were very beautiful, and they present a striking resemblance to some of Koenig's flame pictures. In 1891, Boeke,§ in a laborious microscopical research, measured the transverse diameters of the depressions on the wax cylinder at different depths, and from these measurements calculated the depths of the curves. He then reconstructed the curves on a large scale. During the present year, William Hallock ‖ has photographed the flames of an apparatus somewhat similar to the analyser of Koenig. Manometric capsules were attached to eight resonators, corresponding to the eight tones of a harmonic series, and when the flames were lit, by a device of swinging the

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* Blake, E. W. *A Method of recording Articulate Vibrations by means of Photography.* Amer. Jnl. of Science and Arts, 3rd Series, Vol. XVI., p. 54.

† Referred to in *The Telephone, the Microphone, and the Phonograph,* by Count du Moncel. London, 1884. See also *The Speaking Telephone and Talking Phonograph,* by G. B. Prescott. New York, 1878.

‡ Hermann. *Ueber das Verhalten der Vocale am neuen Edisonischen Phonographen, Pflüger's Archiv,* Vol. XLVII., 1890, p. 42; also *Phonophotographische Untersuchungen,* II., p. 44; also *Phonophotographische Untersuchungen,* III., p. 347.

§ Boeke, *Microscopische Phonogrammstudien, Pflüger's Archiv,* Vol. L., 1891, p. 297.

‖ Hallock. *Photographic Record of Sound Analysis. The American Annual of Photography* for 1896.

camera in front of them, a photograph was obtained of the eight bands of flame as modified by singing the vowels in front of the resonators.

Recently also Pipping,* of Helsingfors, has traced and analysed the curves obtained by a kind of phonautograph constructed on the type of the drum-head of the ear, and R. J. Lloyd,† of Liverpool, has written two valuable papers on the interpretation of the tracings obtained by Pipping and by Hermann.

The phonograph I now show you was one of the first made in this country. It was constructed by the late Professor Fleeming Jenkin in 1876. It represents—

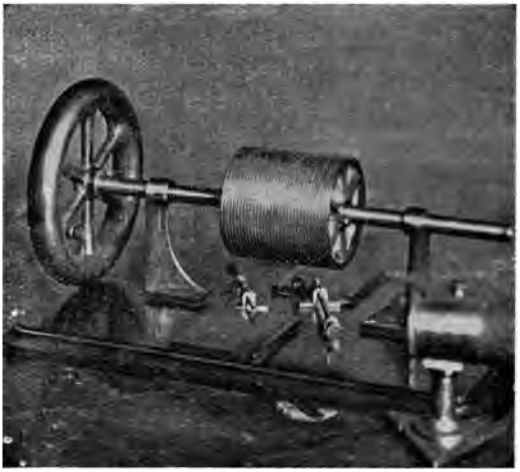

Fig. 13.—The Tinfoil Phonograph.

the phonograph in its simplest form. You observe how the drum travels from side to side, as in the phonautograph. The drum has a deep spiral groove, the thread of which corresponds to that of the spindle on which the drum rotates, and it is covered with thin, soft tinfoil. The membrane has fixed firmly to its centre a stout little marker having a chisel-shaped edge. When sound waves fall on the membrane, it vibrates, and as the drum is rotated, the edge

* PIPPING. *Om Klangfärgen hos sjunga Vokaler;* also *Zeitschrift für Biologie*, Vol. XXVII., p. 1, and XXXI., p. 524.

† R. J. LLOYD. *The Genesis of Vowels*, and *The Interpretation of the Phonograms of Vowels.* Journal of Anatomy and Physiology. Vol. XXXI., New Series. Vol. XI., Part II., Jan. 1897. See also Dr. Lloyd's paper on *Phonetische Studien*, Vol. IV.

of the needle pushes in the tinfoil into the spiral groove, and it makes a series of indentations corresponding to the variations of pressures produced by the sound waves. When the sound is reproduced, we run the point of the needle over these indentations by turning the drum, and the varying pressures on the needle point caused by the indentations act on the membrane, and reproduce the sound. Thus this simple mechanism records the *number* of vibrations, corresponding to pitch, the relative *amplitude* of the vibrations, corresponding to intensity or loudness, and the *form* of the vibrations which has reference to the quality of the sound.

Since this remarkable invention first appeared, the phonograph has been improved so as to make it now a valuable scientific instrument. Many are too apt to think of it as an amusing toy, or as an apparatus that will serve the practical purpose of a shorthand writer. It is both amusing and practical, but it is much more. It is now a scientific instrument worthy of a place in physical and physiological laboratories beside other instruments of scientific research, and those employed for demonstration in teaching. It merits this position because it makes it possible to study some of the phenomena of sound in a manner otherwise unattainable.

Since 1877, the phonograph has been immensely improved, and we now have it in the form that you see before you. The machine used in this country is so geared that the wax cylinder, $6\frac{7}{8}$ inches in circumference, makes two revolutions in one second, while the spiral grooves described on the cylinder are $\frac{1}{200}$th inch apart. A spiral line about 136 yards in length may be described on the cylinder, and the recording or reproducing point travels over this distance in about 6 minutes.

I have also used the American model, now also before you, which resembles in all essential particulars the one I have just described, except that the grooves are $\frac{1}{100}$th inch apart, instead of $\frac{1}{200}$th inch.

The mechanism by which the glass disc or diaphragm communicates its movement is shown by means of the large model now before you. When sound waves fall on the glass disc, the latter is subjected to variations of pressure, as I have already explained. From the centre of the glass disc there comes a rod which passes to the end of a lever, and to this lever a counterpoise is attached. The end of the lever carries a sapphire point which, like a gouge, cuts a spiral groove on the surface of the wax cylinder. When there is increased pressure on the disc, the

inclination of the edge of the gouge is directed downwards at such an angle with the surface of the wax cylinder as to cut a groove of a certain depth; but when the pressure becomes less, the angle is changed, the gouge cuts more in a horizontal direction, and the

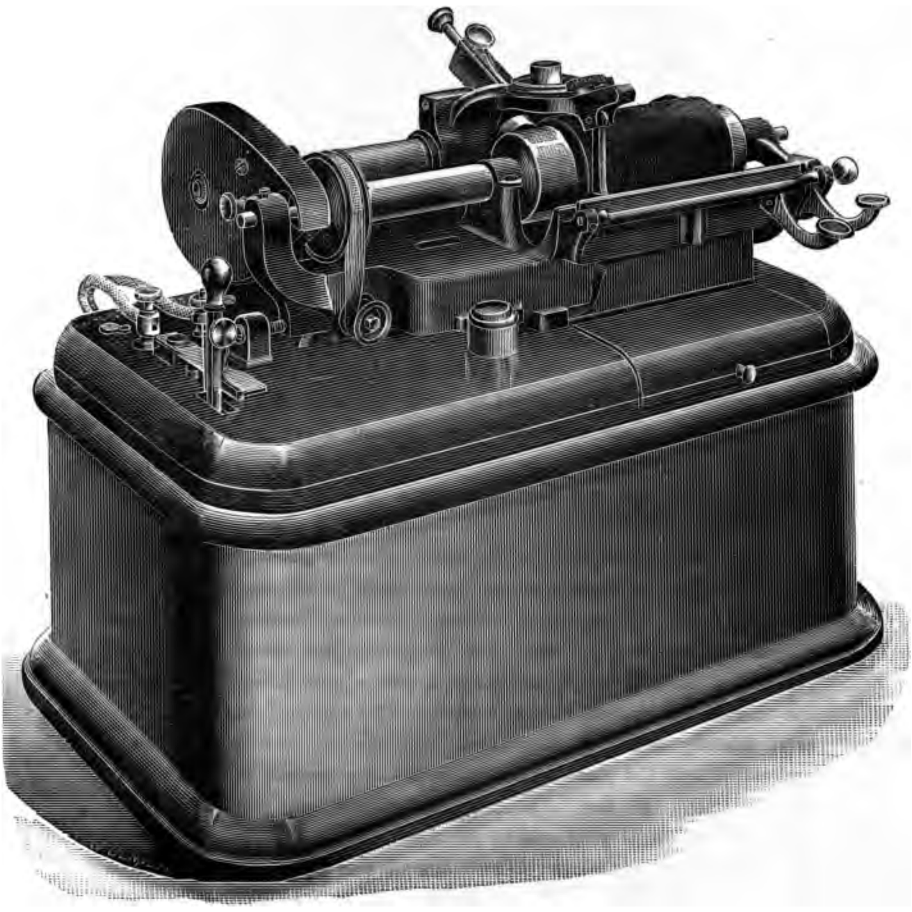

Fig. 14.—The Phonograph. English Model.

groove ploughed out is not so deep. Consequently as with each vibration of sound we have, as I have already explained, increased pressure and diminished pressure. A series of marks of an oblong form are made in the bottom of the groove, each little mark corresponding to a vibration. The number of such marks therefore

in a given distance—which, when the velocity of the movement is taken into account, represents a certain interval of time, say the $\frac{1}{80}$th of a second—corresponds to the pitch of the note; the depth of the marks corresponds to the intensity of the vibration; and the form of the marks to the form of the vibration. Again, suppose a note is sung *diminuendo* to *crescendo* and again to *diminuendo*, the depth of the groove will vary according to the intensity, at first shallow, gradually becoming deeper till the maximum depth has been reached, and again becoming more and more shallow. These marks, therefore, on the wax cylinder are the representations of the mechanical effects of the vibrations in all respects—number (pitch), depth (intensity or loudness), form (quality). It will be evident, therefore, that if we run over these marks again with the reproducing point, the glass disc will again vibrate to the impulses received by the ups and downs on the cylinder as to reproduce faithfully, but with diminished intensity, the original sound. It is, therefore, an investigation of great interest to study these marks, to reproduce them on such a scale as to enable us to study their form, and to let us see the ups and downs as we would do, suppose we could make a longitudinal section along the bottom of the groove and looked at the marks sideways.

Before we set ourselves to the study of these marks, let me bring under your notice certain other branches of the investigation. In the first place, we may, to a wonderful extent, increase the volume of tone or loudness of the phonograph by the use of resonators. No doubt the *quality* of the tones is best appreciated by carrying the vibrations directly to the vicinity of the drum-head of the ear, as is usually done, by fine tubes, but this method is not always agreeable, and the pleasurable effect is sadly marred by the friction noises. Still the fact that tones are heard best in this way, *as regards their quality*, proves to my mind that the marks on the wax cylinder are accurate representations of the varying intensities of the pressures caused by the sound waves. Resonators, such as the large one you now see, increase the volume of tone, and you will notice how accurately the tones are reproduced. I cannot to-night enter on a consideration of the theory of the action of resonators. It is by no means easy to explain how such a one as you see, and by which you now hear, increases the volume of the tone.

Another method is that of Mr. Alfred Graham, which I now show you. A specially constructed carbon transmitter is hung

over the phonograph, and a tube passes from the glass disc of the latter to the carbon plate of the transmitter. A current is sent

Fig. 15.—Phonograph furnished with a large tin-plate resonator (12 feet in length, 3 feet in diameter at wide end).

through the transmitter and thence to a specially arranged loud speaking telephone, before which, you will observe, I have a very large resonator. When the variations of pressure, corres-

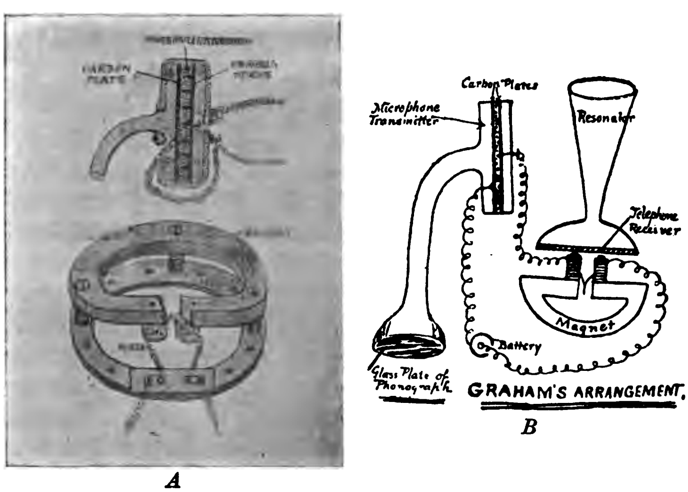

Fig. 15A.—Graham's Variable Resistance Apparatus applied to the Phonograph. *A*, Transmitter above, Telephone below. *B*, Applied to the Phonograph.

ponding to the sound waves emitted from the glass disc of the phonograph, act on the carbon plates and carbon particles of the transmitter, more or less resistance is offered to the current. These variations of resistance act on the telephone, and the sound is reproduced with great intensity by the latter. You will understand Graham's arrangement by the diagram now thrown on the screen, while you hear a trombone solo thus intensified. By this device energy is introduced—that of the battery,—and I feel sure that it is in this direction that further developments may be expected from the phonograph.

Now, let us see what we can make of the marks. I have endeavoured to study the marks on the wax cylinder in three different ways—by casts, by photographs, and by mechanical devices.

As regards the first method, taking casts, which was also attempted by Hermann and Boeke, the results were not satisfactory. The most efficient method followed by me was to paint in the cylinder, with a camel-hair brush, a layer of celloidin dissolved in ether. This soon hardened, and the film could then be peeled off. The thin film thus obtained was then inverted on the stage of a microscope, and the marks were seen in relief. A photograph of the marks thus obtained is now on the screen—

Fig. 16.—Celloidin Cast (Magnified) of Marks on Wax Cylinder. Portion of record of a military band.

The depressions are well seen, and their differences as regards length are obvious. The method has the disadvantage of flattening out the marks.

I took numerous photographs, with the aid of the microscope and camera, of portions of the surface of the cylinder on which

were records of many instruments and of the voice. I now show you on the screen examples of such records :—

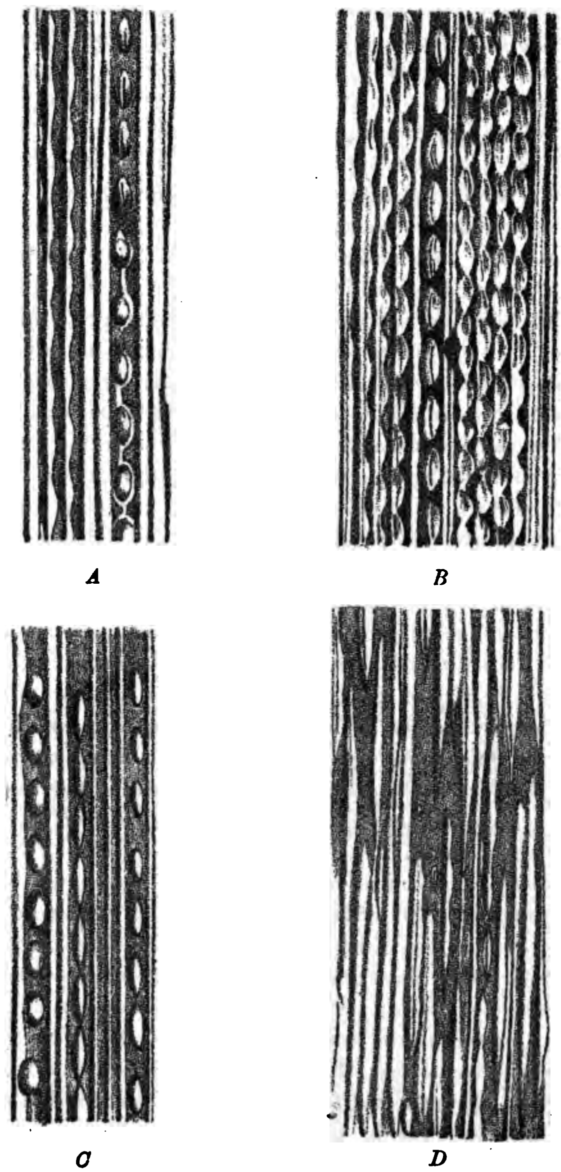

Fig. 17.—From Photographs of portions of the surface of the Wax Cylinder. *A*, Violin. *B*, Flute. *C*, Vowel *o*. *D*, Full Organ.

Each figure, from above downwards, represents the $\frac{1}{8}$th of an inch on the surface of the wax magnified fourteen diameters. The grooves seen in each figure are, on the wax cylinder, $\frac{1}{200}$th inch apart, and the length of the groove, from above downwards, represents in time the $\frac{1}{64}$th second; that is to say, when each tracing was recorded, the sapphire point of the recorder travelled over the distance represented in magnified proportions in the $\frac{1}{64}$th part of a second. By counting the number of indentations or marks, which in a photograph have a curious appearance of being in relief, one can at once determine approximately the pitch of the tone, the vibrations of which make the impression. The tones highest in pitch were obtained from the piccolo and the xylophone. Here the pitch was about 1,920 vibrations per second. In Fig. 17 (*A*) we have a picture of the vibrations produced by the tones of the violin, and it will be seen that they vary in character. Sometimes the marks are a little apart, and at other times they blend into each other, the mark widening out as the receding point cut into the wax and then contracting as it receded. It is to be born in mind that even when the glass disc is not vibrating, the recorder ploughs a groove on the cylinder, and when the glass disc vibrates each vibration cuts deeper into the groove. The figure of the vibration of the tones of a flute (*B*) shows moniliform markings, indicating that the disc may not, in some instances, return to its position of rest for a short time. Sometimes the intensity of the tone is so great as to cause, after each deeply ploughed groove (as will be seen in the figure of the vibrations of the tones of an organ, *D*), a rebound lifting the recorder up to the surface of the cylinder, or even off the surface altogether. This is the explanation of the smooth spaces between the ends of the individual marks.

To obtain a mechanical representation of the curves is a very difficult matter. The difficulties were so far overcome by the device of Jenkin and Ewing with the tinfoil phonograph. The method followed by these observers, which was entirely mechanical, was to cause the disc of the phonograph to record its movements on a drum moved at the same rate as that of the cylinder. As I have already mentioned, Hermann photographed the oscillations of a beam of light reflected from a small mirror connected with the disc of the phonograph, the whole apparatus moving slowly. My method consists in the adaptation of a light lever to the phonograph itself, and so arranged that it (the point of the marker) would

travel over all the ups and downs of the phonographic curve on the wax cylinder at an extremely slow rate. The obvious objection to any method of directly recording the ups and downs of the lever is that the inertia of the lever might cause extraneous

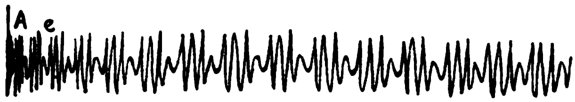

Fig. 18.—Specimen of curves obtained by Professor Hermann. The vowel *a* sung on the note *e*.

vibrations, while, at the same time, the smaller marks on the wax cylinder might be missed. These objections, however, were removed by reducing the friction to minimum, and by moving the phonograph cylinder so slowly as to make the movement almost invisible to the naked eye. In this way inertia ceases to give trouble. The first arrangement gave curves of very small amplitude, a specimen of which I now show you.

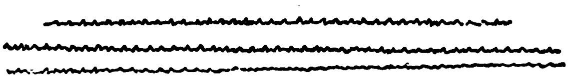

Fig. 19.—Specimen of curves taken with a simple lever. The curves were from the record of a cornet solo.

Various mechanical arrangements were employed, some of which I described to the Royal Society of Edinburgh in February last.*

My attention has since been directed to perfecting a mechanism for obtaining a record of the vibrations, and I wish to acknowledge the great assistance derived from the ingenuity and mechanical skill of Mr. Reid and Mr. Kean, of the well-known firm in Glasgow known by the name of "James White." The instrument now before you (and put into operation by Mr. Kean), which I shall call a *phonograph-recorder*, traces out, on a large scale, the curves of the indentations on the wax cylinder corresponding to each vibration of sound, and it does so in a way that seems to be highly satisfactory. It is now an instrument that can be used by other workers in this difficult department of research, and I hope that some of the younger physiologists and physicists will take the

* M'KENDRICK, *Observations on the Phonograph*, *Trans. Roy. Soc. Edin.*, Vol. XXXVIII., Part IV., No. 22.

From the point of the second lever a thin rigid wire, *g*, passes transversely, 80 mm., to be attached to a thin slip of brass, *g′*, bearing a fine glass syphon, like the syphon, *m*, used in the well-known syphon recorder of Lord Kelvin. This strip of brass bearing the syphon is attached to an upright rod, *h*, bearing a circular weight at its lower end, *k*, delicately pivotted above and below, and having a fine watch spring attached to its upper end, *i*. The syphon is placed horizontally, with the longer limb, *m*, towards the front of the apparatus, and with the shorter limb, *e*, dipping into an ink-pot, *n*. The ink used is a filtered solution of an aniline colour. It will be evident, on looking at the plate, that any movement of the second lever is thus communicated to the syphon, and that oscillations of the syphon are controlled by the weight and the spring already described. The amplification of the movement is also greatly increased.

The paper on which a tracing is taken is rolled out below the long end of the syphon by an ingenious electro-motor arrangement recently devised for Lord Kelvin's syphon recorder. It will be remembered that, in the usual form of Lord Kelvin's syphon recorder, the ink, electrified by the well-known "mouse-mill," spurts out on the band of paper, o^{III}, and thus a line is recorded in a series of dots and without friction. The new arrangement gets rid of the mouse-mill. The mechanism, oo^{II} (electro-magnetic), which draws the paper forwards, at the same time vibrates up and down through a very short distance, and thus, at short intervals of time, brings the paper against the minute drop of ink at the end of the syphon. Thus the end of the syphon does not rub on the paper, and there is practically no friction. The tracing appears as a line formed of a number of minute dots, the distances between which correspond to the rate of vibration of the apparatus.

The apparatus is worked by a storage cell, *p*, of about 6-8 volts, and it runs at such a speed that 24 feet of paper are rolled out during the time of one revolution of the phonograph. Consequently, on a length of 20 feet of paper, we obtain a record of all the vibrations that were recorded on $7\frac{7}{8}$ths inch of surface of cylinder, or in a period of half a-second. One foot of paper would therefore represent $\frac{1}{40}$th second, and one inch would represent $\frac{1}{480}$th of a second.

The amplification vertically is nearly 1,000 times, but in the direction of length it is only about 35 times magnified. To obtain the tracings so as to increase the amplification in length to

correspond to the amplification in height—that is to say, to 1,000 times—it would be necessary either to drive the phonograph 36 times slower, or a speed of one revolution in about 5 hours, or to roll out the paper 36 times faster, or about 864 feet in 8 minutes, instead of about 24 feet. Manifestly either of these devices would be very inconvenient, and it is unnecessary to attempt to carry these out, as for purposes of analysis it does not matter. In the description of the few curves of phonographic records I have seen taken by Hermann and Pipping, nothing is said in explanation of the fact that the tracings are not amplifications to scale of the true marks on the phonographic cylinder. I show you here (1) a tracing of the vibrations of a bugle, taken by my apparatus, giving an amplification about 1,000 times vertically, and 35 times in a linear direction, and (2) a tracing of a few of these curves enlarged longitudinally so as to have the vertical and longitudinal amplifications equal—about 1,000 times. It will be observed how the impressions are long, shallow depressions, very shallow at first, gradually becoming deeper towards the centre, and again becoming shallow towards the other end. In this aspect they exactly resemble the grooves seen in photographs taken of portions of the surface of the wax cylinder.

One of the chief difficulties in earlier experiments with this instrument was to secure that the point of the first lever always was in contact with the horizontal portion of the short arm of the second lever, and that, on the other hand, the pressure was not too great. If the mechanism be considered, it will be apparent that, supposing the grooves on the wax cylinder to deepen, as would be the case if the sound recorded became more intense, the whole of the aluminium lever would fall, and its point would pass too heavily on the arm of the second lever. On the other hand, suppose the groove to become shallow, as happens when the sound is less intense, the aluminium lever would rise, and, as it is rigid, its point might come off the horizontal arm of the second lever. In the first case, when the pressure was too great, the curves recorded on the paper would be less in height than they ought to be, and, if the point of the lever came off the horizontal arm of the second lever, or touched it with a series of knocks, either no curves at all were obtained, or the curves were not transcripts of the marks on the cylinder.

I endeavoured to meet this difficulty by turning the screw in

the plate which raises or depresses the arm bearing, in the usual phonographic arrangement, the reproducing diaphragm, or, as in my instrument, the aluminium lever. Still it was difficult to do this accurately. At last the difficulty was got over by an automatic device. On the top of the screw for raising or elevating the aluminium lever, we fixed a round shallow drum, *r*, 80 mm. in diameter, and covered, on its outer surface, with sandpaper, so as to be rough. Then the cord passing from the electro-motor to the phonograph for driving slowly the mandril bearing the wax cylinder, c^{IV}, was brought round a pulley, *s*, seen in Fig. 20, and then transversely in front of the side of the roughened drum, *r*. The cord then passed round another pulley, *t*, attached to the keeper of an electro-magnet marked *u* in the plate, and then back to another pulley passing transversely to the roughened drum and parallel to the first cord. It then passed round a second pulley, marked *v* on plate, then round the pulley on the phonograph, and back to the electro-motor. When the electro-motor worked, the cord moved slowly in front of the roughened drum, and one portion moved in one direction while the other moved in the reverse direction. If the lower cord, t^{I}, touched the roughened drum, it would be moved on, carrying the screw with it, in the direction say of the hands of a watch, but if the upper cord, t^{II}, touched the side of the roughened drum, then the direction of the rotation of the screw would be in the opposite direction. It will be evident that the one movement might lower the aluminium lever, while the other might raise it.

In the next place, to make the apparatus work automatically, a slender platinum wire, *w*, was attached to the aluminium lever, about 15 mm. from its point. This was caused to dip into a little trough, *x*, containing mercury resting on a horizontal metal arm passing out from the support bearing the aluminium lever, but immediately beneath the lever and parallel to it, *zz*. Below the pulley round which the cord passed there is an electro-magnet, and the pulley is so attached to the keeper of the magnet as to be oblique. When the magnet is not acting, the keeper is free, the lower cord touches the roughened drum, and the latter moves in a given direction. If, however, the magnet acts, the keeper bearing the pulley is pulled to one side, so as to bring the upper cord against the roughened drum, and the latter moves in the opposite direction. Thus the movement of the screw by which the aluminium lever may be raised or depressed is regulated by the roughened drum,

and this again by the electro-magnet and the two cords. Finally, the electro-magnet is brought into action when the platinum wire or the aluminium lever dips into the mercury. This diverts a portion of the current that drives the paper feeder into the electro-magnet, the latter then acts, and the upper cord is brought into play. The following is an account exactly of what occurs :—

1. When the reproducing point connected with the aluminium lever *sinks too low,* the wire attached to the lever dips in the mercury, the current is made, the armature is drawn forward, the upper cord presses on the rough cylinder, the cylinder with the screw turns in a direction against that of the hands of a watch, the bearer of the lever and the reproducing point are lowered, the reproducing point, pressing on the cylinder, therefore lifts the lever and *the free end of the lever is raised.* Again,

2. When the reproducing point rises too high, the wire attached to the lever is lifted out of the mercury, the current is broken, the armature falls away by the action of a counterpoise, the lower cord presses on the rough cylinder, the cylinder and screw are turned in the direction of the hands of a watch, the bearing apparatus is raised, the recording point on the aluminium lever is relatively lowered, and the *free end of the lever falls.*

By this arrangement, which may be called an automatic "finger and thumb" for turning the screw in reverse directions, there is a constant self-adjustment according to the depth of the grooves on the wax cylinder, which again corresponds with the varying intensity of the sounds.

Since the apparatus was brought to its present condition, I have been able to record the vibrations of the tones of several instruments, and also the tones of the human voice, both in singing and in speech. Illustrations of these I now show you, and they will be represented in two plates to be appended to this lecture when printed. It is important to remember that in these tracings 1 linear foot shows the vibrations occurring in about $\frac{1}{40}$th of a second.

First, with reference to speech, I wish to point out that when the record of a *word* is examined it is found to consist of a long series of waves, the number of which depends (1) on the pitch of the vowel constituents in the word, and (2) on the duration of the whole word or of its syllables individually. There is not for each word a definite wave form, but a vast series of waves, and, even although the greatest care be taken, it is impossible to obtain two

records for the same word precisely the same in character. A word is built up of a succession of sounds, all usually of a musical character. Each of these sounds, if taken individually, is represented on the phonograph-record by a greater or less number of waves or vibrations, according to the pitch of the sound and its duration. The pitch, of course, will depend on the number of vibrations per second, or per hundredth of a second, according to the standard we take, but the number of the waves counted depends on the duration of the sound. As it is almost impossible to utter the same sound twice over in exactly the same fraction of a second, or in the same interval of time, the number of waves counted varies much in different records. The rate per unit of time determines the pitch, the number the duration of the sound. In a word, these successive sounds blend into each other, and, in many records, the passage from one pitch to another can be distinctly seen. The speech sounds of a man vary in pitch from 100 to 150 vibrations per second, and the song sounds of a man from 80 to 400 vibrations per second. The sounds that build up a word are chiefly those of the vowels. These give a series of waves representing a variation in pitch according to the character of the vowel sound. In the record of a spoken word the pitch is constantly moving up and down, so the waves are seen in the record to change in length. It is also very difficult to notice where one series of waves ends and where another begins. For example, in the word *Con-stan-ti-nople*, the predominant sounds are those of *o-a-i-o-ill*, and the variation in pitch is observable to the ear if, in *speaking* the word, we allow the sound of the syllables to be prolonged. If we look at the record of the word (as seen in the seven lines in Plate I., reading from left to right), we find these variations in pitch indicated by the rate of the waves, or, as the eye may catch this more easily, by the greater or less length of wave, according to the pitch of the sound. The consonantal sounds of the word are breaks, as it were, in the stream of air issuing from the oral cavity, and these breaks (I am not discussing the mechanism at present) produce sounds that have also often the character of vowel sounds. Thus, at the beginning of "Constantinople," we have, as will be observed on pronouncing the syllable very slowly, the sound *ŭkkō*. This sound is represented in the record by a series of waves. Then follow the waves of the vowel *o*. Next we have the sound *nn* (driving the air through the

nose), also represented by a series of waves, and then the hissing sound *ss*, which has first something in it of the vowel *e* or *i*, and then the *iss-s*. This sound also is shown by a series of waves. Then there is *ta*, which has a double series of waves—first, those for *it* or *t*, and the next for *a*. This passes into the prolonged vowel *a*, this into *in*, this followed by *ti* passing into the vowel *i*, then another *in*, then a long *o*, then a sound like *op*, and, lastly, the sound *ill*, a sort of double-vowel sound. As so many of these sounds have the character of vowels, it is impossible, by an inspection of the record, to say where one set of waves begins and another ends. There are no such breaks corresponding to the consonants; the vibrations of the consonants glide on as smoothly as those of the vowels. The *number* of waves producing a word is sometimes enormous. In "Constantinople" there may be 500, or 600, or 800 vibrations. A record of the words "Royal Society of Edinburgh," spoken with the slowness of ordinary speech, showed over 3,000 vibrations, and I am not sure if they were all counted. This brief illustration gives one an insight into nature's method of producing speech sounds, and it shows clearly that we can never hope to read such records in the sense of identifying the curve by an inspection of the vibrations. The details are too minute to be of service to us, and we must again fall back on the power the ear possesses of identifying the sounds, and on the use of conventional signs or symbols, such as letters of the alphabet, vowel symbols, consonant symbols, or the symbols of Chinese, which are monosyllabic roots often meaning very different things according to the inflection of tone, the variations in pitch being used in that language to convey shades of meaning.

When human voice sounds are produced in singing, especially when an open vowel sound is sung on a note of definite pitch, the record is much more easily understood. Then we have the waves following each other with great regularity, and the pitch can easily be made out. Still, as has been well pointed out by Dr. R. J. Lloyd, of Liverpool, a gentleman who has devoted much time and learning to this subject, it is impossible by a visual inspection of the vowel curve to recognise its elements. Thus two curves, very similar, possibly identical to the eye, may give different sounds to the ear—that is to say, the ear, or ear and brain together, have analytical powers of the finest delicacy. No doubt, by the application of the Fourierian analysis, we may split up the periodic wave into a fundamental of the same period, and

a series of waves of varying strength vibrating 2, 3, 4, 5, &c., times faster than the fundamental, and the relative amplitude of each of these may be determined. If all these waves of given amplitude and given phase acted simultaneously on a given particle, the particle would describe the vibration as seen in the original curve. Dr. Lloyd, however, is of opinion that even a Fourierian analysis may not exhaust the contents of a vowel, as it does not take account of inharmonic constituents which may possibly exist. Hermann* and Pipping† have also been investigating the analysis of vowel tones, and their investigations have revealed many difficulties. Hermann experimented with the ordinary phonograph, and obtained photographs of the movements of the vibrating glass plate. His curves are small, not unlike those seen in Koenig's flame pictures, and they do not seem to me to represent so fairly the marks on the wax cylinder as those obtained by my apparatus. In many cases they have sharp points (Fig. 18). This, however, may not interfere with analysis. Pipping's curves were not obtained from the phonograph, but from the vibrations of a minute membrane made to represent the drum-head of the ear. His curves show large periodic waves with minute waves on their summits, and they suggest that the large waves may be vibrations due to the membrane itself. Not having seen the apparatus, and as the observations have been made by one well aware of the possibility of this error, I do not venture to do more than suggest this difficulty, especially as I now show you a series of tracings on a glass plate very similar to those in Pipping's figures. These were obtained by singing a vowel into a receiver furnished with a small membrane, to which a recorder was attached. The glass plate (smoked) moved rapidly across in front of the marker. Alongside of these you will see curves obtained directly from the recorder attached to the glass disc of a phonograph. In the second you see waves more like those of Hermann. The larger waves in the tracing, like that of Pipping, are, I believe, due, in my experiment, to the vibrator, and do not represent the glottal vibrations. This conclusion is strengthened

* Hermann. *Ueber das Verhalten der Vocale am neuen Edisonische Phonographen. Pflüger's Archiv*, Vol. XLVII., 1890; also *Phonophotographische Untersuchungen, op. cit.*, ii. and iii.

† Pipping. *Om Klangfärgen hos sjungna Vokaler.* Discussed in Dr. Lloyd's paper on the Interpretation of the Phonograms of Vowels, *op. cit.*

by noting the pitch of the sound, as made out by counting, not the larger, but the smaller waves, which corresponds to that of the vowel sound. I therefore think that argument should be based only on records obtained from the phonograph itself, which is furnished with a vibrator that will not record its own periodic vibrations unless the sound be remarkably intense. In ordinary voice production and in ordinary singing, the vibrator of the phonograph faithfully records only the pressures falling upon it—no more and no less.

I shall now show you another method of recording, not the individual vibrations of the phonograph, but the variations in intensity of the sounds of the phonograph—the intensities of individual notes and chords. I was led to use this method by becoming acquainted with an instrument devised by Professor Heurthle, of Breslau. He has succeeded in recording the vibrations of the sounds of the heart. I saw that his instrument was very useful, and I adapted it to the particular purpose in hand. Heurthle's instrument is an electro-magnet acting on a metal plate connected with the elastic membrane of a tambour. Another drum is connected with the first by an india-rubber tube. The metal plate of the first tambour is pulled down by the electro-magnet; thus the air is rarified in the tube and in both tambours, and the lever of the second tambour moves. The next instant the lever flies back. We shall now connect Graham's variable resistance apparatus with the phonograph. As sound waves fall on it, a change is produced in the current passing through the electro-magnet; the latter acts on its tambour; a variable pressure is communicated to the other tambour; and if the lever of the latter is brought against a revolving drum, a tracing is obtained. I show you a little bit of such a tracing.

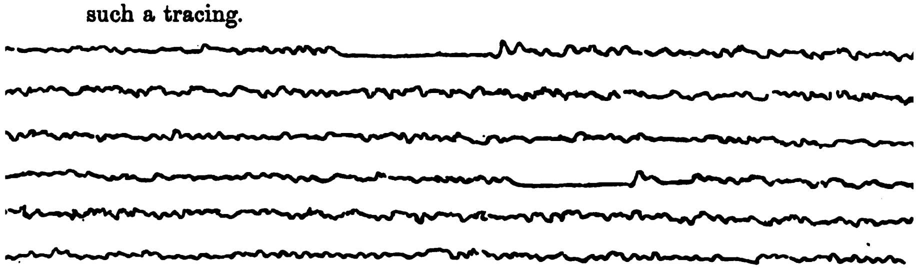

Fig. 21.—Portion of a record of the time and intensity of music played by a military band. Each curve represents a note or chord. The curves are read from right to left. The cylinder in which the record was taken was moving slowly, about 1 inch per second.

Each note and each chord are recorded, so that you get a mechanical tracing of the variations of intensity. Now this experiment suggested another of a different kind. Suppose I send the current not only through the variable resistance apparatus above the disc of the phonograph, but also through the primary coil of an induction machine. The wires from the secondary coil pass to two platinum plates dipped in weak salt solution. I now set the phonograph going; and when I put my fingers into the beakers containing salt solution, I *feel* the intensity of every note. The variation of intensity, the time, the rhythm, and even the expression of music, are all felt. I shall now place on the mandril of the phonograph a cylinder on which has been recorded another piece of music, which is much quicker. I now feel a series of electrical thrills corresponding to every variation of intensity of sound coming from the phonograph.

That method shows that the nerves of the skin can be stimulated by irritations coming to it at the rate of the notes and chords of rapid music. Some of the notes produced by the phonograph do not last longer than the five hundredth or six hundredth part of a second, but they are quite sufficient to stimulate the nerves of the skin, and, as I have pointed out, you can appreciate the variations of intensity. You can *feel* the long drawn-out notes from the saxhorn or trombone. You feel the *crescendo* and *diminuendo* of rhythmic movement, and you can estimate the duration of the note and chord. You feel even something of the expression of the music. It is rather a pity to say that even expression is mechanical. It is undoubtedly mechanical when you deal with the records of the phonograph. A number of interesting questions of a physiological nature are suggested by this experiment. The skin is not a structure that can analyse tone or distinguish pitch; it cannot tell you the number of vibrations, although there is a curious approach to it. While it is not by any means accurate, you can distinguish tone of low pitch—very low tones—by a feeling of "intermission." Experimenting in this way, you may stimulate by interrupting this circuit at the rate of 30 or 40 or 50 breaks per second, and yet the skin will tell you the individual breaks; but when you get above that number you lose the consciousness of the individual breaks, and you have a more or less continuous sensation. The phonograph does not necessarily give you 50 or 60 *stimuli* to produce a sensation of a tone; you do not require that number. I found that 8 or 10 per second may give you the sensation for a tone

of any pitch. In the same way you may be able to notice a slight difference up to perhaps 50 or 60, but above that the sensation seems continuous. It is not the number of *stimuli* that determine pitch, but the rate at which the *stimuli* affect the sense organ, whether it be ear or skin. Then the question arises, What is it in the skin that is irritated? It is not the corpuscles. They have to do with pressure. There is no organ for the sense of temperature. You may say that the feeling is muscular. Possibly it may be so; but the effect is most marked when the current is so weak as to make it unlikely that it passes so deep as to reach the muscles.

This experiment suggests the possibility of being able to communicate to those who are stone deaf the feeling, or, at all events, the rhythm of music. It is not music, of course, but, if you like to call it so, it is music *on one plane and without colour.* There is no appreciation of pitch or colour or of quality, and there is no effort at analysis, an effort which, I believe, has a great deal to do with the pleasurable sensation we derive from music. In this experiment you have the rhythm which enters largely into musical feeling. On Saturday last, through the kindness of Dr. J. Kerr Love, I had the opportunity of experimenting with four patients from the Deaf and Dumb Institution, one of whom had her hearing up till she was eleven years of age, and then she became stone deaf. This girl had undoubtedly a recollection of music, although she does not now hear any sound. She wrote me a little letter, in which she declared that *what she felt was music*, and that it awakened in her mind a conscious something that recalled what music was. The others had no conception of music, but they were able to appreciate the rhythm, and it was interesting to notice how they all, without exception, caught up the rhythm, and bobbed their heads up and down, keeping time with the electrical thrills in their finger tips.

Lastly, I must say a word as to how the ear analyses such compound waves as we have been considering. Here are eight tuning forks, arranged in a harmonic series, Ut_2, Ut_3, Sol_3, Ut_4, Mi_4, Sol_4, Si (7), and Ut_5. I now sound all these, and you hear a rich mass of tone produced by a highly complex wave built up of the eight waves emitted by these eight forks. The ratio of the vibrations of these forks is 1 (Ut_2), 2, 3, 4, 5, 6, 7, and 8. This compound wave traverses the air of the room and falls on the drum-head of your ear. You hear the fine rich tone; but pay

close attention, and you will hear some of the tones comprising it; at all events, you will pick out of the mass of sound any tone that I make a little more intense than the rest, by gently bowing the corresponding fork. Listen. You now hear the tone of Sol_3, now that of 7, now that of the fundamental first tone, Ut_2. Suppose we had another set of forks at the other end of the room exactly tuned to these eight, when the compound sound wave floated over them, each fork, by sympathetic resonance, would pick out its own tone. In short, the eight forks at the other end of the room would analyse the compound wave sent out from the eight forks at this end of the room. Now, as we have the power of analysis—even musically deficient people have this power—we must have, in the internal ear, some kind of vibrators tuned to all the tones we can perceive, from 30,000 to 40,000 vibrations per second. The nerves are thus affected; the message goes to the brain; and we hear a tone, simple or compound, according to the nature of the waves falling on the drum-head of the ear. This, which is substantially the theory of Von Helmholtz, is, I hold, the only one that will in any adequate way account for the perception of tone. Behind the ear lies the brain. The messages ultimately reach it, but of what occurs there we know nothing.

The PRESIDENT—Ladies and Gentlemen,—I am sure we have all listened with intense interest to this most admirable demonstration which Professor M'Kendrick has given us to-night. The occasion of this particular lecture is that 25 years ago, or thereabout, there was in Glasgow a committee of gentlemen who arranged a series of science lectures, and these gentlemen brought down to Glasgow all the most eminent scientists of the day, and I daresay there are many ladies and gentlemen present who had the privilege of listening to some of those science lectures. By-and-by the interest of the public or these gentlemen began to wane, and they handed over a sum of money to the Philosophical Society in order to perpetuate these lectures in some fashion. From time to time, as our means afforded it, we have had the privilege of having lectures similar to the one that you have listened to this evening, and I am sure that Dr. M'Kendrick, who has done very many eminent services to the Philosophical Society, and who has been one of our most eminent members, has never done a better service to the Society than he has done to-night. He has given us the advantage of an enormous amount of investigation. These investigations must have cost many months

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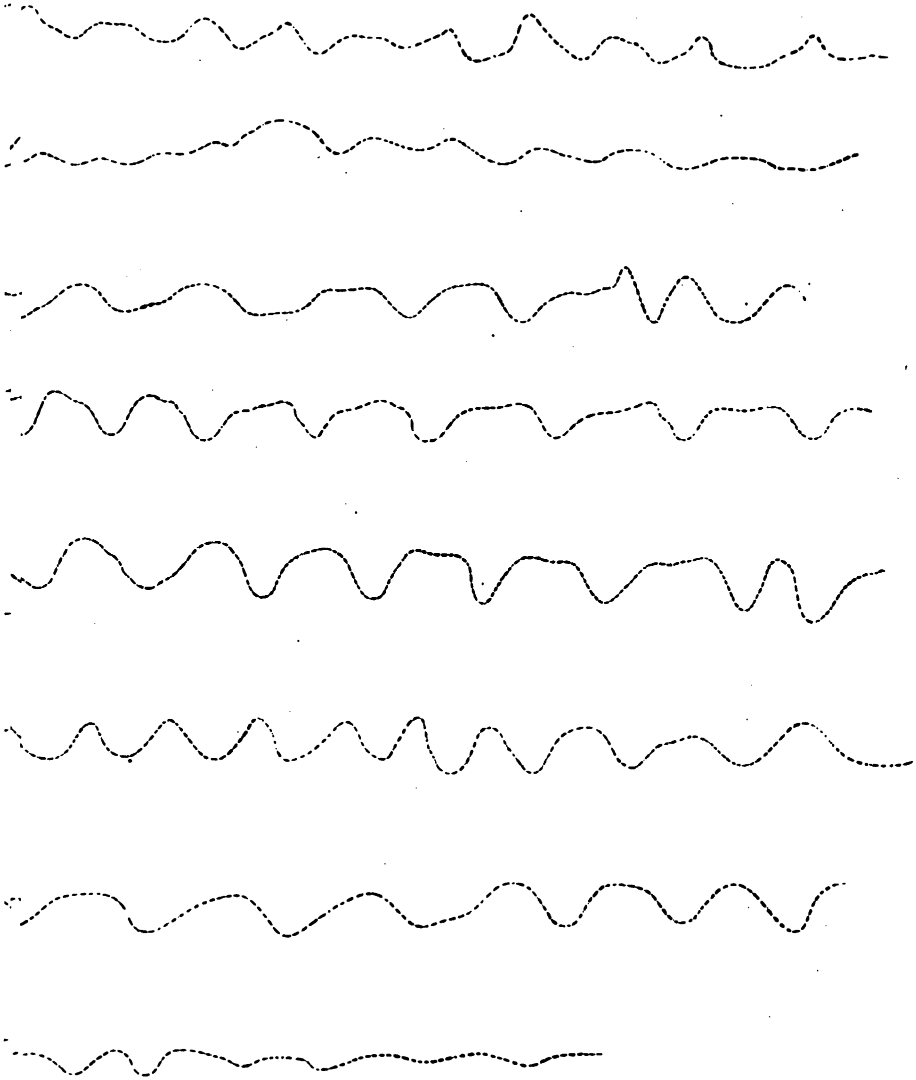

Maclure, Macdonald & Co. Lith. Glasgow

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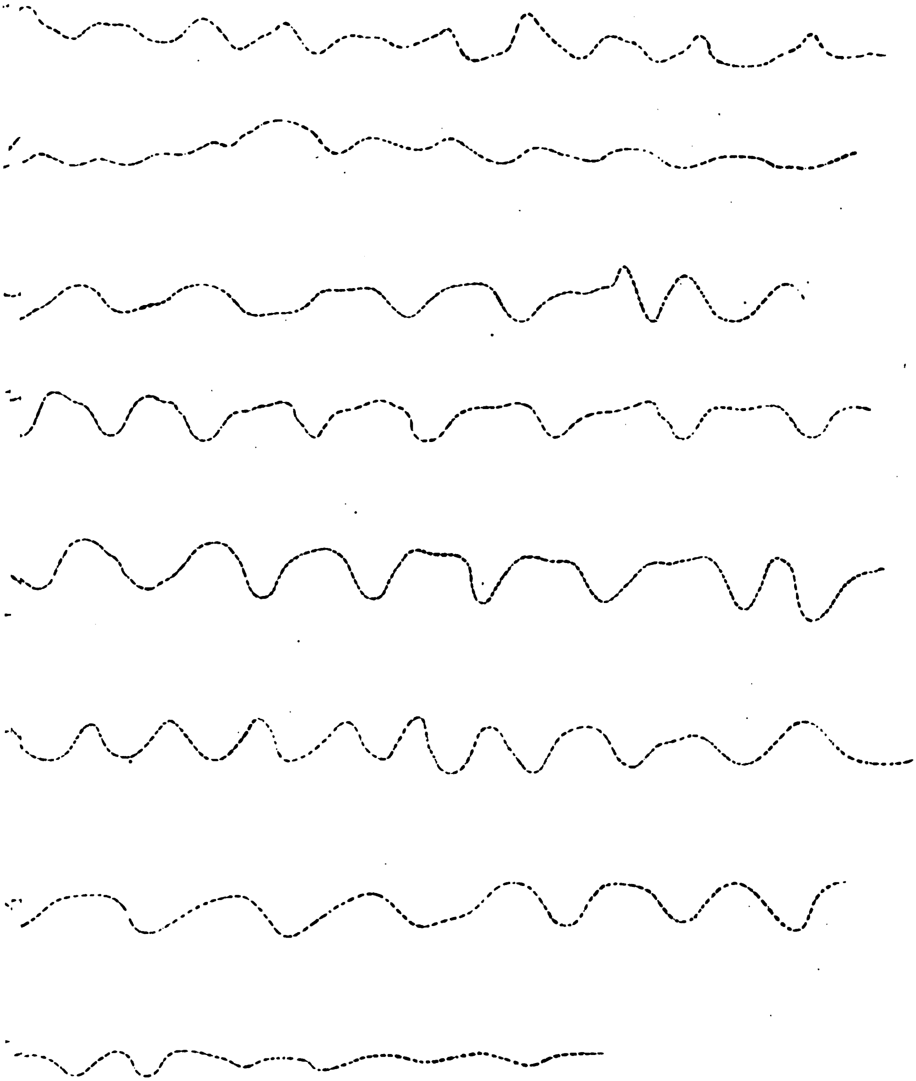

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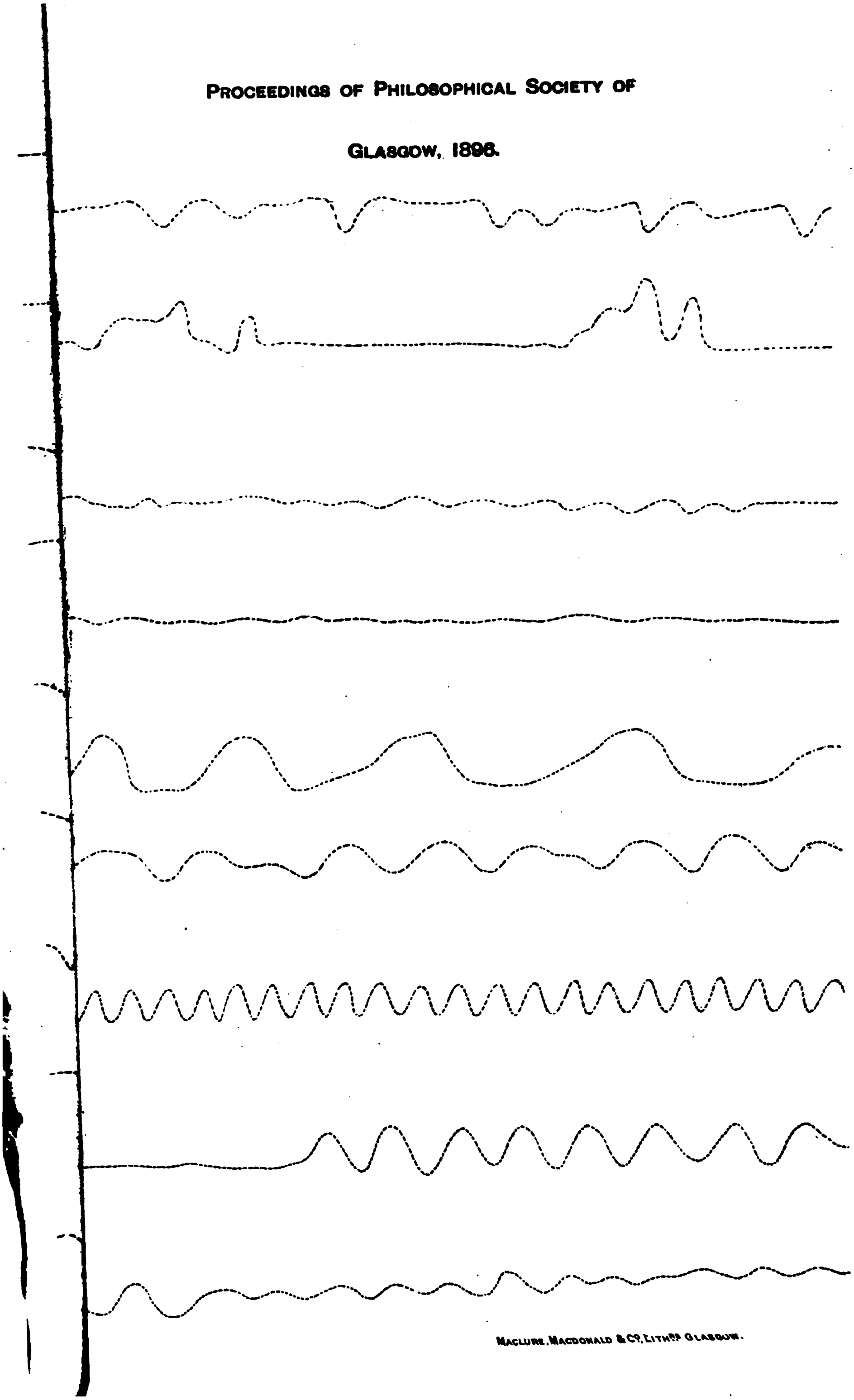


MACLURE, MACDONALD & CO. LITH^{RS} GLASGOW.

of very great trouble and very great anxiety in the manipulation of these exceedingly elaborate instruments, and he has done to-night what you might expect some wonderful magician to do. He has made the eye do what it never was intended to do, and speech to do what it never was intended to do, and the nerves of touch to act in such a way that they can appreciate sound. I think we are all under a great debt of gratitude to Dr. M'Kendrick, and I hope that this is the beginning of the series, and that by-and-by the development may be still more wonderful and interesting. I have great pleasure in asking you to award him a very hearty vote of thanks for this most admirable demonstration that he has now given us.

DESCRIPTION OF PLATES.

PLATE I.—Curves taken with the Phonograph Recorder from records of concertina, flute, and of the word "Constantinople."

PLATE II.—Curves taken with the Phonograph Recorder from records of cornet, the sounds of quick-firing guns, the noises of a boiler-maker's shop, a soprano voice, bugle, bass trumpet, piccolo, euphonium, and military band.

One foot, linear (300 mm.), shows the vibrations occurring in $\frac{1}{40}$th (0·025) second.

XII.—*The Vaccination Commission's Report: A Plea for Re-vaccination.* By JOHN C. M'VAIL, M.D., F.R.S.E., Medical Officer of Health for the Counties of Stirling and Dunbarton.

[Read before the Society, 20th January, 1897.] *

PROBABLY no medical question has ever been subjected to more prolonged and elaborate scrutiny than the question of vaccination. Not only have medical men studied it in all its aspects during the century whose end is now so nearly approaching, but, as a result of its relationship to legislation, Parliament itself has repeatedly caused the whole subject to be investigated and reported on for the public benefit. In 1802 a Committee of the House of Commons heard evidence and presented a report; in 1871 there was another Select Committee; and in 1889 the Royal Commission, whose Report we are about to consider, commenced its seven years labours. A Royal Commission, needless to say, differs from and is broader than a Select Committee, in that it does not require to be confined to Members of Parliament.

The report of the Commission is signed by eleven members. Three of these are distinguished lawyers, namely—the Chairman, Lord Herschell, lately Lord Chancellor of England; Judge Meadows White, Q.C.; and Mr. John S. Dugdale, Q.C. Other three are, or were, Members of Parliament, namely—Sir Charles Dalrymple, Mr. Samuel Whitbread, and Mr. John Albert Bright. A seventh is Sir Edwin Galsworthy, chairman of the Metropolitan Asylums Board. The remaining four are medical men—Sir James Paget, Professor Michael Foster, Mr. Jonathan Hutchinson, and Sir W. Guyer Hunter. The last-named is also an ex-Member of Parliament. Mr. Jonathan Hutchinson had, many years previously, done more than any other medical man to prove to the profession and the public that the conveyance of a foul disease by means of vaccination is not an absolute impossibility. Two members of the

* This paper was partly read and partly given *extempore*. The latter part, as reproduced here, is from notes supplied by Dr. M'Vail.

Commission declined to sign the report. These are Dr. W. J. Collins, formerly a vice-president of the London Society for the Abolition of Compulsory Vaccination, and Mr. J. A. Picton, formerly M.P. for Leicester.

The conclusions of the Commission regarding the power of vaccination over smallpox may be summarised thus:—Vaccination diminishes liability to attack by smallpox; when attack does come, vaccination modifies the character of the disease, rendering it milder in type and less fatal in result; protection against attack is greatest during the years immediately succeeding vaccination, and the duration of highest protection may perhaps be stated as covering a period of nine or ten years; even after this period of highest protective potency has elapsed, protection against attack is considerable for another quinquennium, and possibly never altogether ceases; the power of vaccination to modify the severity of the disease outlasts its power to prevent attack by the disease, and the modifying power even during the later periods of life is still very considerable; re-vaccination restores the protection which time has diminished, and further repetition of the operation is needed if it be desired "to ensure the highest degree of protection which vaccination can give;" and, lastly, the benefits of vaccination are increased by the thoroughness with which the operation is performed, and this thoroughness is represented by the number and area of the vaccinal insertions, three or four being better than one or two, and an area of at least half a square inch better than anything considerably less.

Another question before the Commission was the alleged dangers of vaccination. Here it is necessary to note the pains taken by the Commissioners to make themselves fully acquainted with the facts. They did not trust to the Medical Department of the Local Government Board to investigate cases of alleged injury, but appointed medical inspectors of their own to go to all parts of England inquiring as to everything they could hear of as needing inquiry. Regarding the means they took to hear of cases of alleged injury, they speak in Sections 405 and 407:—

"405. Since the 1st of June, 1889, we have, from time to time, been informed from various sources of cases in which death or non-fatal injury has been alleged or suggested to have been caused by or otherwise connected with vaccination with a view to their investigation, and since the 14th of February, 1891, the Local Government Board have immediately informed us of all such cases brought to their notice. In March, 1892, the Home Office addressed a circular letter to coroners throughout England and Wales,

requesting that in all cases where they received information that the death of any person, on whose body they proposed to hold an inquest, had been alleged to have been caused by, or to have had any connection with, vaccination they would communicate immediately with the Commission."

"407. We have not any means of ascertaining in what number of cases some other disease has supervened on vaccination as a consequence of it, without producing a fatal result. We are able, however, to form some judgment upon this point by observing the number of non-fatal cases to which our attention has been called. We do not mean to suggest that we have been informed of all cases of this nature which have occurred during the last six years. There have very likely been many cases which have not come to our knowledge, where the inflammation set up has been more than usual, and some where a slight attack of erysipelas has resulted. But when we consider that the fact that we were engaged upon this inquiry has been thoroughly well known, and that active organisations and zealous individuals were at work searching out cases in which the results of vaccination had been abnormal, with a view to bring them under our notice, and that some of those which we were asked to investigate turned out to be of a trifling or unsubstantial nature, we think we are able to form a fairly accurate estimate of the amount of injury which can be plausibly attributed to vaccination. A consideration of all the circumstances has led us to the conclusion that, as regards the non-fatal cases with which we are now dealing, serious injury cannot have resulted in any considerable number of cases."

Their conclusion is in Section 434 :—

"434. A careful examination of the facts which have been brought under our notice has enabled us to arrive at the conclusion that, although some of the dangers said to attend vaccination are undoubtedly real and not inconsiderable in gross amount, yet when considered in relation to the extent of vaccination work done they are insignificant. There is reason further to believe that they are diminishing under the better precautions of the present day, and with the addition of the further precautions which experience suggests will do so still more in the future."

Still another question is—"What means, other than vaccination, can be used for diminishing the prevalence of smallpox, and how far such means could be relied on in place of vaccination?" To this subject the Commissioners devote much attention. They heartily recognise the value of isolation as an *auxiliary* to vaccination, but as a *substitute* for vaccination they have no faith in it.

"502. The question we are now discussing must, of course, be argued on the hypothesis that vaccination affords protection against smallpox. Who can possibly say that if the disease once entered a town, the population of which was entirely or almost entirely unprotected, it would not spread with a rapidity of which we have in recent times had no experience, or who can foretell what call might then be made on hospital accommodation if all

those attacked by the disease were to be isolated? *A priori* reasoning on such a question is of little or no value."

"503. We can see nothing, then, to warrant the conclusion that in this country vaccination might safely be abandoned, and replaced by a system of isolation. If such a change were made in our method of dealing with smallpox, and that which had been substituted for vaccination proved ineffectual to prevent the spread of the disease (it is not suggested that it could diminish its severity in those attacked), it is impossible to contemplate the consequences without dismay.

"To avoid misunderstanding, it may be well to repeat that we are very far from under-rating the value of a system of isolation. We have already dwelt upon its importance. But what it can accomplish as an auxiliary to vaccination is one thing, whether it can be relied on in its stead is quite another thing."

Thus the Commission have concluded:—

(*a*) That vaccination and re-vaccination prevent and control smallpox;

(*b*) That smallpox cannot be prevented and controlled without vaccination and re-vaccination; and

(*c*) That these preventive means are very safe, and that any very slight risk which does exist can be made much less by proper attention to details.

It is not my intention to-night to discuss these conclusions of the Commission. For the purposes of this paper they must be held as correct, and what I wish is to call your attention to the administrative, and especially to the legislative, proposals of the Report.

As to administration, the principal recommendations are shortly as follow:—

(*a*) The use of calf lymph.

(*b*) The postponement of the vaccination age from three months in England to six months, as in Scotland.

(*c*) The instruction of parents in the avoidance of abrasion and injury and fouling of the vaccine vesicle.

(*d*) That the vaccine vesicle be not broken.

(*e*) That vaccination be performed at the child's own home instead of at a public station.

(*f*) That the vaccinated arm be inspected in the second and third week after vaccination.

(*g*) That vaccination be postponed if the surroundings are insanitary, or if erysipelas, scarlet fever, &c., are prevalent.

(*h*) That the child be removed from insanitary surroundings while it is under vaccination.

(*i*) That lymph be preserved in tubes instead of on dry points, and perhaps also that glycerine be used.

(*j*) That vaccination be performed with simple and easily cleaned instruments.

(*k*) That all vaccination instruments be boiled or otherwise sterilised.

(*l*) That insertions of lymph on the arm be not made too closely together.

(*m*) That any medical attendance required in consequence of vaccination be paid for by the State.

The Commission make certain proposals regarding relaxation of the present vaccination law. In this connection it is to be clearly understood that the purpose of the proposals is *not* to diminish the amount of vaccination in the country, but to increase it. The Commissioners believe that a too severe law does more harm than good, by stirring up ill-feeling and giving opportunity for cheap martyrdom. It is for such reasons only that they suggest that the law should be modified, and even this is safeguarded by the further suggestion that any modification should be merely temporary, and that the matter should come up again for reconsideration at the end of five years.

The purpose of the proposals is twofold—(*a*) to give effect to conscientious objections, and at the same time (*b*) to prevent omission of vaccination as a result merely of parental indifference or neglect. The practical test which they wish to apply to separate out these two classes, (*a*) and (*b*), is a system of registration of "conscientious objection," which shall be so troublesome that a parent who is merely indifferent will find it quite as convenient to get his child vaccinated as to go through all the routine prescribed by the new law. Exact details are not given, but we may presume that the intention is that there should be a sworn declaration made in presence of witnesses in a law court, and afterwards recorded in the books of the district registrar. How far such a scheme would effect its purpose must be matter of opinion, and, in the absence of experience, an opinion is not easily formed.

In places where the vaccination laws are at present a "dead letter," infantile vaccination would probably be considerably increased. In places where the law is well administered, the change would probably diminish vaccination.

It is to be noted, however, that the suggested scheme applies only to infantile vaccination. This brings us to what appears to me to be the main flaw in the Commission's Report. Regarding the value of re-vaccination the Commission speak with no uncertain voice. Its value for adolescents and adults is in a great degree comparable with that of primary vaccination for infants and children. But as regards legislation for re-vaccination the Commission write as follows :—

"533. We have already adverted to the importance which we attach to re-vaccination. It has been suggested that the operation should be made compulsory by law. We are quite alive to the protective value of general re-vaccination. At the same time we are not insensible of the difficulties necessarily involved in rendering it compulsory. It is, comparatively speaking, easy in the case of infants to ascertain whether the law requiring vaccination has been complied with. The constant movement of the population would render it much more difficult to ascertain whether at the more advanced age at which it would become applicable a law providing for compulsory re-vaccination had been observed. Again, it is impossible to leave out of sight the effect that such an extension of the present compulsory law might have in intensifying hostility where it at present exists, and even in extending its area; though if our recommendations, especially that which exempts from penalty those who honestly object to the practice, were adopted, this objection would be much diminished. After full consideration of the question, we are, however, deterred by the considerations to which we have adverted from proposing that re-vaccination should be made compulsory. At the same time, in view of the great importance of re-vaccination, we think it should be in every way encouraged. If an adequate fee were allowed in every case of successful re-vaccination, by whatever medical man it was performed, we think there would probably be a large extension of the practice. We think steps should be taken to impress on parents the importance of having their children re-vaccinated not later than at the age of twelve years. We recommend further, that when smallpox shows signs of becoming epidemic, special facilities should be afforded both for vaccination and re-vaccination."

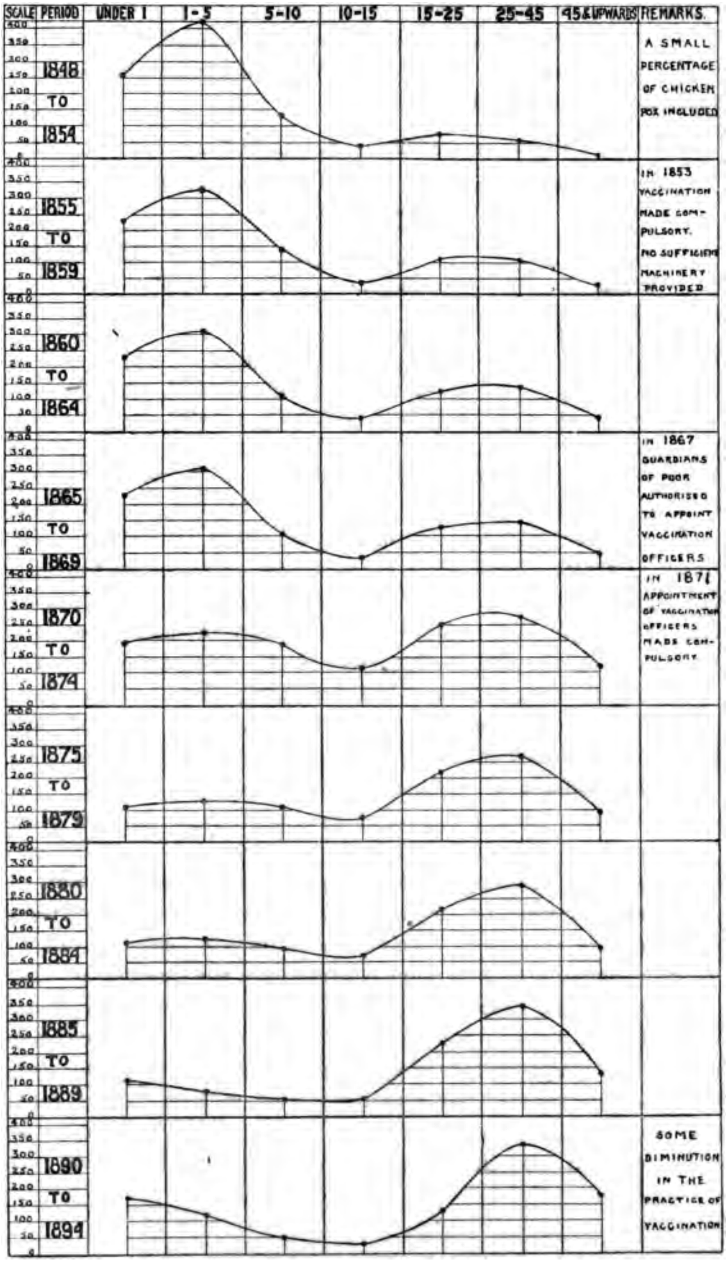
It is a very curious fact that the Commission here do not discuss the applicability to re-vaccination of the proposed legal procedure as above sketched with regard to primary vaccination. In saying "it has been suggested that the operation should be made compulsory by law," they are merely setting up a man of straw in order to demolish him again. It is not easy to suggest any hardship in applying to re-vaccination those proposals regarding

conscientious objection and registration, &c., which they make for primary vaccination. Seeing that, in the opinion of the Commission, re-vaccination is desirable at twelve years of age, and seeing that parents should have this fact "impressed" on them, why should not the pressure take the form of the necessity on the part of the parents, either of making a declaration of conscientious objection to the vaccination of their children at ten or twelve years of age, or else of getting them vaccinated. It is, indeed, easy to understand that many parents who might have sentimental scruples as to the insertion of lymph on the arm of their baby of six months might have no objection to the vaccination of the same child when he had become a sturdy boy of ten years old. And if the child had been primarily vaccinated in infancy, and had thereby been protected from smallpox, why should not the law insist that, in the absence of declared conscientious objection, the protection should be repeated at the age of ten or twelve years?

The importance of re-vaccination is well illustrated in the evidence given before the Commission. In former centuries smallpox was a disease of childhood, just as measles and whooping-cough are in the present day. Of every 100 cases of the disease in many epidemics, 90 or thereby were in children under five years old. Since the introduction of vaccination this age incidence has been remarkably altered. It is the children now who most largely escape and the adults now who are most largely attacked. The reason is not far to seek. Formerly the children were unprotected and were attacked, and those who recovered had thus acquired protection by smallpox itself. Nowadays the children are protected by vaccination, and in adults the protection has more or less worn out and requires renewal. The following diagram, copied from *Public Health* (Nov., 1896), indicates for successive periods the gradual change of age incidence that has occurred since the middle of the present century. I have mentioned that in the last century children under five accounted for 90 out of every 100 deaths from smallpox. The diagram shows that by the middle of the present century this contribution of 900 per 1,000 had already been considerably reduced under optional vaccination. So-called compulsory vaccination came into force in England from 1853, and the gradual diminution of the children's share of smallpox is shown in successive periods in the diagram. In the last period, however (from 1890 to 1894), there is indicated a tendency to increase of smallpox under five years of age. It is

ENGLAND AND WALES

DEATHS FROM SMALL POX AT CERTAIN AGE PERIODS TO 1,000 DEATHS FROM SMALL POX AT ALL AGES.



during this period that anti-vaccination has been the most rampant. A suggestion has been made by certain opponents of vaccination that the explanation of this remarkable alteration in the age incidence of smallpox since pre-vaccination times is to be found in sanitation, or is due to certain vaguely named "cosmic" or "telluric" influences. This transcendental explanation has its reply in the following table:—

PERCENTAGE OF TOTAL SMALLPOX DEATHS

Borne by Children under 10 years of age in Recent Outbreaks in various Towns.

Towns.	Vaccination Default.	Percentage of Total Smallpox Deaths borne by Children.
Warrington,	very slight,	22·5
Sheffield,	,,	25·6
London,	in 1883-91, 10 per cent.,	36·8
Dewsbury,	in 1882-92, 32·3 per cent.,	51·8
Gloucester,	in 1885-94, 10·6 to 85·1 per cent.,	64·5
Leicester,	in 1883-92, 43·8 to 80·1 per cent.,	71·4*

* Or 66·6 (see Section 182.)

In Warrington and Sheffield vaccination of infants was well carried out, and when smallpox attacked these towns children under ten years old contributed only 22·5 and 25·6 to every 100 smallpox deaths. In London there was in 1883-91 a ten per cent. default in vaccination. The children's share of smallpox deaths rose to 36·8 per cent. Dewsbury and Leicester and Gloucester have been among the headquarters of the anti-vaccination cult, and these three towns have had recent experience of smallpox. In Dewsbury the default in vaccination was 32·3 per cent., and the children's share of smallpox amounted to 51·8 per cent. In Gloucester default of vaccination ranged from 10·6 to 85·1 per cent., and the children's share of smallpox rose to 64·5 per cent. In Leicester vaccination default ranged from 43·8 to 80·1 per cent., and the children's share of smallpox amounted to about 70 per cent. Sheffield is declared by anti-vaccinators to have been an insanitary town, yet, vaccination of infants being prevalent, children contributed only a low percentage of the smallpox deaths. Leicester, on the other hand, is declared to be a sanitary town, but, infantile vaccination being in abeyance, the children contributed a high percentage of the total smallpox deaths. In short, in these communities the contribution by children to the total smallpox deaths corresponded to the neglect of the vaccination of children. All this illustrates the urgent need that exists not

only for systematic primary vaccination, but for systematic re-vaccination. The working years of life, from adolescence onwards, have the same right to vaccinal protection administered by the State as have the years of infancy and childhood. If in the future "conscientious" objection to primary vaccination is to have the consideration given to it which the Commission approves, there surely can be no objection to applying the same modified law with regard to the vaccination or re-vaccination of children at ten or twelve years of age.

My purpose in this paper has been two-fold—(1) to remove from the minds of those who read or hear it, any confusion which may exist as to the attitude adopted by the Royal Commission with regard to the present vaccination law, by pointing out that the Commission have the most thorough belief in the need for vaccination, and that their purpose in proposing a relaxation of the law is not to diminish, but to increase, the practice of primary vaccination; and (2) to point out that the only logical conclusion to the Report of the Commission concerning the value of re-vaccination is, that whatever administrative measures, and whatever modified legislative pressure, are to be continued or introduced for the promotion of primary vaccination, should be equally applied to re-vaccination. In this way, and in this way only, can the vaccinal protection of the people of this country against smallpox be complete, whether or not it be universally enforced.

XIII.—*The Law of Mutual, or, rather, Common Gables.*

By George G. Paton, M.A., LL.B., Writer, Glasgow.

[Read before the Architectural Section, 15th February, 1897.]

Mutual or common gables are by no means peculiar to Scotland, nor is their history of yesterday. They were adopted even in the days of ancient Greece and Rome. Thus the wall that separated the houses of Pyramus and Thisbe is spoken of by Ovid as a mutual gable or *paries communis*—

> Fissus erat tenui rimâ, quam duxerat olim,
> Cum fieret paries domui communis utrique.
> —Ovid, *Met. IV. 65 and 66.*

And we read in Thucydides (II. 3) that the Platæans, resolved on an attempt to overpower the Thebans, who had unexpectedly entered their city, proceeded to join each other by digging through the common gables (κοινοι τοιχοι) of their houses that they might not be seen going through the streets. In Scotland, as in other places where they have been recognised, the origin of mutual gables has been expediency. In centres of population, where curtailment of space is of the first importance, it is not surprising that the erection of one gable, where otherwise two gables of equal thickness would have been required, was thought of, and soon assumed the position of a right by law.

Confining ourselves to the law of Scotland, though much of it on this subject is derived from the Civil Law of Rome, and keeping in view what has been said as to their origin, we can readily apprehend that it is not on the boundary of every property that an owner of that property is entitled to build mutual gables.

Where, then, can mutual gables be built? In burghs, and where there is to be a continuous line of building in a street, such a privilege prevails; but apart from contract, or special circumstances implying contract, it finds a place nowhere else. This point was discussed and decided in the protracted litigation that took place

in 1874 and 1875 between the trustees for the Deacons' Court of Newington Free Church and Mr. Jack. Those parties were proprietors of adjoining pieces of ground at Causewayside, Edinburgh. Jack took down the garden wall between the properties in question, which had been erected about a century before, when the district was in a rural condition, and proceeded to erect a mutual gable in its stead. While an attempt was being made to adjust the terms upon which the other parties were to get the benefit of the gable when built, the operations of Jack were not stopped. An amicable arrangement failed to be effected; and, when the gable was nearly finished, the church trustees raised in the Sheriff Court at Edinburgh a summary action of interdict and removal against Jack. (Begg and others *v.* Jack, 10th January, 1874, I. R. 366.) The Sheriff-Substitute granted interim interdict, and afterwards pronounced an interlocutor ordering Jack to take down the gable and restore the wall to the condition in which it was before it was interfered with, and interdicting him from using the wall in any way except as a division wall until any question there was of heritable title had been competently decided. The First Division of the Court of Session, to whom the case was appealed, recalled the judgment and dismissed the action. On the principle that it is no use "closing the door of the stable when the steed is gone," the Court will not grant interdict unless such an action is raised timeously; accordingly, the interim interdict granted by the Sheriff-Substitute was recalled, and, in respect that, where no sudden erection has been made, a petition for summary removal of a building of four storeys is inappropriate, the craving for removal, &c., was refused. No opinion was expressed as to whether Jack's operations were lawful or not. Jack now retaliated by taking out, in the Court of Session, an action of damages against the trustees for the loss which he had suffered in being delayed in the construction of his building by the interim interdict that had been granted by the Sheriff-Substitute on the application of the trustees; and this movement on the part of Jack was followed by the trustees raising an action of declarator and removal to have it found and declared that Jack had exceeded his rights in taking down the boundary wall and erecting a mutual gable, and to have him ordained to remove the gable and re-erect the boundary wall. (Jack *v.* Begg and others, and Begg and others *v.* Jack, 26th October, 1875, 3 R. 35.) The result of these two cases was that both the Lord Ordinary and

the Second Division held that Jack was not entitled to erect a mutual gable where he had done so, and absolvitor in favour of the trustees was therefore granted in the action of damages; while in the action of declarator the Court, though holding that Jack had acted unlawfully in building a mutual gable, yet, in the exercise of their equitable jurisdiction, did not compel Jack to take down the gable, as the loss to Jack would have been out of all proportion to any advantage to the trustees, but, in respect that his operations were illegal, granted leave to the trustees to make use of the gable at any time without any payment whatever. Before dealing with the point I have in hand, I should like to mention, without digressing unduly, that Lord Watson, in a later case (Graham *v.* the Magistrates of Kirkcaldy, 26th July, 1882, 9 R. (H. L.) 91), said in regard to this decision:—"I desire to say that, whilst it may fairly be accepted as an authority in favour of the equitable jurisdiction of the Court, I am not satisfied that the result at which the Court arrived is such as your Lordships ought to approve. . . . The judgment humbly appears to me to trench upon private rights of property to an extent altogether unwarranted by any previous authority in the law of Scotland. The practical effect of the judgment was that the Court gave the wrong-doer compulsory powers to acquire part of his neighbour's property, which, in spite of remonstrances, he had illegally appropriated."

But to return to the cases with which we were dealing: Lord Gifford said—"Where adjoining lots of ground are feued or sold for the purpose of building a continuous street, the owner of any one of the lots in building his tenement constructs his gables one-half upon the adjoining lots, so as to be mutual gables. . . . But all this proceeds upon a tacit or implied contract inferred either from the feuing plan according to which the line of street is to be built, or from the special circumstances of each case. Where there is no room for such implied contract and implied consent, the rule does not hold, and the builder of a tenement must build it, gable and all, entirely upon his own ground, unless he gets the consent of his neighbour. . . . For example, in villa feuing, where each villa stands entirely in its own ground, and the lots are divided by mere mutual garden walls, I do not think that the proprietor of one villa lot is entitled, without his neighbour's consent, to remove the garden division wall and erect a gable, one-half upon his neighbour's ground and that at any

spot he pleases, without any regard to the plans or wishes of his neighbour. . . . In like manner, where even in a street a church has been built entirely within its own ground, I do not think that adjoining proprietors, apart from contract express or implied, can insist upon building the gables of their houses, one-half upon ground belonging to the church, although the church and its proprietors can never take any benefit from such gables as mutual gables." In the case of Lamont *v.* Cumming, to which I shall afterwards have occasion to refer, the late Lord-President Inglis remarks in regard to the mutual gable :—"It was originally built according to the time-honoured custom of burghs in Scotland ;" and in Sinclair *v.* Brown Brothers, to which reference will also be made, he uses much the same language as Lord Gifford in the opinion I have already quoted. "I think," says Lord Inglis in that case, "that the common law rule just amounts to this, that in towns where continuous streets of houses are being built, the party erecting a gable wall is entitled to erect it half on his own ground and half on that of his neighbour. This rule admits of a good many exceptions, and would not be enforced, except in cases where continuous streets are being built, or unless, in other circumstances, it was made clear in the contract that the gable was to be built on the ordinary terms."

Now, whose property is a mutual gable when built? Much diversity of opinion has existed in regard to this question. So far as I can see, there have been three views.

The first view is that the builder of the mutual gable is the sole proprietor of it until his neighbour pays a share of its cost. In Hunter *v.* Luke and others, hereafter cited, Lord Jeffrey's opinion is thus expressed :—"The proprietor of the house is the sole proprietor of the common gable until the party to divide it with him comes into existence. He is sole proprietor, with a kind of conventional servitude provided in favour of the party who comes to build on the adjoining stance, to have right to one-half on paying the party who built it, or the party to whom he may have conveyed it." To a similar effect speak Lord Shand, as Lord Ordinary, in Rodger *v.* Russell, and the late Lord Justice-Clerk Moncreiff in the same case. The former judge commences his note as follows :—"In the ordinary case, the person who builds a mutual gable in compliance with the usual stipulations in his feu contract does not thereby add to his neighbour's property to the

extent of the building erected on the ground adjoining his own, for the maximum *inædificatum cedit solo* does not apply. He has right to the whole wall or gable, subject to the obligation to give to the adjoining proprietor, in return for payment of one-half of the total expense, a right not to the part of the wall built on his ground, but a common or *pro indiviso* right to the whole wall"; and the latter Judge, when advising the case in the Inner House, adds:—"When one of the conterminous proprietors of urban feuing ground builds, the adjacent stance remaining unbuilt, the gable, although partly built on the *solum* of the adjacent ground, remains or becomes the sole property of the man who built, with a power to the adjacent proprietor to acquire a *pro indiviso* right in it when he comes to build on paying half the expense of it, and an obligation on him when he builds to pay."

The second view is that the mutual gable is from the first the common property of both neighbours, though the second builder is not entitled to the beneficial enjoyment of it till he pays his share of its cost. In Walker and others *v.* Shearer, afterwards referred to, the late Lord President Inglis thus expresses himself:—"We do not require any evidence of what is meant by a mutual gable: it is a wall in which there is a right of common property in the proprietor of the one house as much as in the other, whichever party builds it; but, of course, the one that does not erect it must pay a part of the expense as a condition of his right of common property." And again, in Lamont *v.* Cumming, the same Judge elaborates that dictum in this way:—"A gable is a subject of common property in a somewhat different way from any other thing; in this respect, that when it is originally built, the party who builds has the only beneficial enjoyment. The party who comes after has a right *in futuro*, which is available to him only when he comes to build. That is a very curious position of matters. There may exist a right of common property, in one sense, even at that time; but it is a different description of right in the one party and in the other, as regards the active title and possession."

The third view is that the builder of the mutual gable is, from the first, proprietor of only the half built upon his own property, with a common interest in the whole; but that, in respect of his having built a mutual gable, he has a right to exclude his neighbour using the gable until he has been repaid a share of its cost. In Robertson *v.* Scott, with which case I shall deal more fully later on,

Lord Rutherfurd Clark formulated such a view in these terms—"Where a gable of this sort is built in part upon the ground of the adjacent proprietor, the right of the builder necessarily stops at the central line which is the termination of his own property, and when the former occupies that gable it is not common property, because that would be contrary to the title; but each has property, each for his own share, while each has common interest in the whole. The builder is at first proprietor of only half the wall; and the consequence of that position is that he has, by the fact of building and so long as he remains proprietor, the right to prevent any person from using it until he has paid the cost of half of it."

It seems to me that the last view is the correct one. On the one hand, I cannot understand how the builder is the sole proprietor of the entire gable, because, were that so, something more than the mere payment of a share of the cost would be essential to divest him of a share of the gable and to transfer that share to his neighbour. On the other hand, it appears to me to be inaccurate to describe at any time a mutual gable as common property; for one proprietor of common property cannot, without the consent of all the others, alter the state of the common subject, whereas, as we shall see, certain alterations and additions may be effected by one party on and to a mutual gable without the consent of the adjoining proprietor. The true view, then, in my judgment, is, that each party is proprietor of the half built upon his own ground, with a common interest in the whole; and, in treating of common property and common interest, Professor Bell says that "it is necessary to discriminate carefully whether a right be of the one class or of the other."

Till payment be made, there is, of course, a right in the builder and his successors to exclude any person from using the gable. What is the nature of that right of exclusion? Notwithstanding what the late Lord-Justice Clerk Moncreiff says in Robertson *v.* Scott, I think it is beyond doubt that the right is real and not personal.

What follows from this nature of the right?

I.—The builder's singular successor, though in his conveyance there be no mention of the mutual gable, is the person entitled to receive payment when it is due. The right to receive payment runs with the lands, and requires no special conveyance. In

Hunter *v.* Luke and others (2nd June, 1846, 8 D. 787), the advocator Hunter was the trustee on the sequestrated estates of Stewart, who was a feuar from the Magistrates of Dundee of a piece of ground in Reform Street there, and the respondents were Wilson's trustees, who had lent a sum of money on the security of part of the tenement erected by Stewart on that piece of ground under an *ex facie* absolute disposition qualified by a back bond. The tenement had a mutual gable, and, when the adjoining stance came to be feued, these feuars were willing to pay their half of the cost of the gable; but a question arose as to the party to whom the payment fell to be made. The respondents, who were infeft upon the absolute disposition, claimed such portion of the adjoining feuars' half of the cost as was applicable to the subjects conveyed in the absolute disposition; Hunter, on the other hand, claimed that he was entitled to receive payment of the whole of the half, and that the respondents were not entitled to receive any portion of it. The Court held that the respondents' contention was sound, as the right to claim a share of the expense of a mutual gable was real and passed by a conveyance of the tenement without any special mention of it. In the words of Lord-President Boyle, "the right to claim did not require to be specially conveyed or made the subject of an assignation," or, in Lord Mackenzie's, "the builder of the gable is entitled to prevent the other from touching it till he has been paid the half, but the right of exclusion is real: it is nothing whatever to do with personality."

Nor is it of any consequence though the mutual gable itself was erected by the common author of both parties. In the Glasgow Royal Infirmary *v.* Wylie and others (June 15th, 1877, 4 R. 894), such was the case. The pursuers were the proprietors of the tenement, No. 38 Cambridge Street, Glasgow, and the defenders, the trustees for the Bath Street Baptist Chapel, became owners of the stance immediately to the south. Both lots of ground, when unbuilt on, were once the property of Mr. Sharp, having been acquired by him at different times. He built upon the boundary between the two lots a mutual gable, when erecting a tenement upon the former. This lot, with the buildings upon it, was sold, and ultimately acquired by the Royal Infirmary. When the Bath Street Chapel Congregation acquired their lot and built upon it their subjects, consisting of shops below and a chapel above, they made use of the mutual gable. When called upon by the pursuers to pay their proportion, the defenders pleaded that the mutual

gable had been erected by the common author of both parties, and that therefore no claim arose by the one proprietor against the other; but the Court held them liable, being of opinion that the common author in disposing the lot, with the buildings thereon, to the pursuer's authors conveyed a right as against himself and his singular successors in the other lot to recover the proportion applicable to that lot of the mutual gable whenever it came to be used by them. The late Lord-President Inglis there said, "That right passed to Mr. Sharp's disponee under the conveyance as a pertinent of the property thereby conveyed. Had Mr. Sharp continued himself the owner of the unbuilt-on stance, and afterwards proceeded to build on it, I think, he would have himself been liable just as the Bath Street Chapel Congregation are now."

In Berkeley *v.* Baird (16th February, 1895, 22 R. 372), William Murray was the heritable proprietor of two conterminous lots of ground in Braid Road, Edinburgh. Upon one of them he erected a house with the north gable built partly upon one lot and partly upon the other. He then conveyed that lot with the house upon it to Colonel Berkeley, the disposition bearing that the gable was a mutual gable. On the day before the conveyance was executed, Mr. Murray's agent wrote to the agent of the purchaser—"It is, of course, understood that the unused halves of gables and boundary walls are not conveyed to your client." Murray thereafter conveyed the unbuilt lot to his agent, Mr. Baird, who proceeded to build a house making use of the gable. Thereupon Colonel Berkeley raised an action against Baird for half the cost of the gable. It was held that he was entitled to recover the amount from Baird, as the right to receive payment was a real right passing to the pursuer under the disposition in his favour, and that the letter was quite consistent with the disposition, because, as I have endeavoured to show, the builder of the gable is at no time proprietor of the whole gable, and the letter merely corroborated the disposition that the conveyance did not extend beyond the mutual line of the wall. Had the letter been contradictory to the conveyance, it would not, of course, have been competent to refer to it.

II.—The obligation to pay the price transmits against a singular successor. In Law *v.* Monteith and others (30th Nov., 1855, 18 D. 125), the lots of ground were situated in Garscadden Street, Glasgow, and once belonged to Messrs. William Hutcheson & Co. They conveyed the westmost lot to Messrs. Lorimer &

M'Gowan, who erected the subjects, the eastern wall of which formed the mutual gable in dispute. Sometime afterwards the surviving partner of Lorimer & M'Gowan disponed the subjects to Monteith's trustees, the respondents. Hutcheson & Co. then became bankrupt, and their trustees sold and disponed the eastmost lot, then still unbuilt-on, to a William Hutcheson, who again conveyed it to the advocator Law by contract of ground annual. Law proceeded to erect buildings on the lot, and in so doing made use of the mutual gable, but refused to pay any portion of the cost of the mutual gable, in respect, *inter alia*, that any such obligation did not transmit against singular successors. The Court held him liable, Lord-President M'Neill stating "that the nature of the property imports an obligation to pay upon the party who uses it (the gable). . . . The understanding of the law is that if a party takes advantage of a mutual gable, he takes it on the condition of paying for it."

I may here bring under notice an interesting and instructive case bearing on the two points we have just been considering. The case is that of the Earl of Moray and his Curator *v.* Aytoun and Maconochie (30th November, 1858, 21 D. 33). The Forsyths took one of several feus of the lands of Drumsheugh, Edinburgh, under conditions applicable to all the lots, binding purchasers, where there were mutual gables already built, to pay half the expense within a month. After erecting cellarage and laying down pavement and paying Ness — feuar of the next stance (which was already built upon)—for the mutual gable, they, by agreement with the Earl of Moray, who was the superior, gave up the feu and assigned to the Earl all claims they had to the mutual gable. Ten years afterwards, the superior feued out the feu, that had been so given back, to Mr. Maconochie, one of the defenders, without reservation or stipulation as to the mutual gable. In the meantime Ness's trustees had conveyed their feu to a Mr. Smyth, who in turn had conveyed it to Professor Aytoun, the other defender. Mr. Maconochie, when he made use of the gable, paid Professor Aytoun half the cost; and when the superiors heard of this, they raised an action against Professor Aytoun and Mr. Maconochie for the sum. It was held that the pursuers had no claim to sue, in respect that they had conveyed the feu without reservation or stipulation. Lord Wood observed—"They have admittedly feued out that area to Mr. Maconochie with all rights belonging to a

feuar, which must include both a right to the area itself and also to that half of the mutual gable built upon a portion of it." Opinions were expressed that if any person had a right to claim the half it was Professor Aytoun, because he was the singular successor of the builder, and had a real right as against the new feuar. But was he entitled to receive, as he did, payment of the half? Notwithstanding the opinions of some of the judges, I think, for reasons which I shall give later on, that he was not, and that an action of repetition by Mr. Maconochie against him would have been successful. You will bear in mind that payment had been made by the Forsyths to Ness; consequently, it seems to me, from that moment the right of exclusion in Ness and his successors ceased.

I should here state, however, by way of parenthesis, that if there be a contract, the obligation to pay has been held not to be cancelled by giving back the ground to the superiors. In Thorburn *v.* Pringle and Caldwell (11th July, 1832, 10 S. 822), the Governors of Heriot's Hospital exposed to feu by public roup certain lots of ground in Perth Street, Edinburgh, under articles of roup whereby, *inter alia*, the exposers were not to be bound to pay for mutual gables for any of the lots to be exposed, but the purchasers were to have power to add to their lots 15 inches for the purpose of each mutual gable, and should be entitled to claim the expense of building the half of said gable from the purchaser of the adjoining lot . . . and to be paid within one month after such lots are feued. The suspender and the chargers took adjoining lots. The latter built, but the former did not. The chargers raised an action for half of their gable. In this action the suspender let judgment go by default. He then entered into an arrangement with the superior to take back the ground and discharge him of all bygone feu-duties and all other claims in relation to the feu which could be made against him by the Governors. The chargers did diligence and the suspender suspended; but both the Lord Ordinary and the Second Division refused the Bill of Suspension, in respect that the superiors had no power to discharge, and that there was a *jus quæsitum tertio* in the purchasers.

III.—The claim on emerging is entitled to a preferable ranking, should the adjoining owner be then bankrupt. On this point let me cite two cases—Wallace *v.* Brown (1808 M., App., personal and real, No. IV.), and Rodger *v.* Russell (10th June, 1873, 11 M. 671). In the former case, relating to subjects in

Heriot Row, Edinburgh, the feu contracts bound the feuars to build mutual gables, with right of recourse to each against his neighbour on the latter beginning to build on his own site. The pursuer had erected a building with a mutual gable, but the feuar of the adjoining stance became bankrupt before beginning to build at all. It was held not only that the claim had emerged (for reasons which will be afterwards adduced), but that it was a preferable claim on the price of the bankrupt's lot of ground. In the latter case the pursuer took a feu at Dalry. In his feu contract it was stipulated that the gables of the tenement he was to erect "shall be mutual gables, and shall be built to the extent of one-half of the thickness thereof on the ground hereby feued, and to the extent of the other half on the ground adjoining, . . . and the cost of erecting said gables shall be borne equally by the feuars." This provision was made a real burden. The pursuer erected on his feu a building with a mutual gable to the south. Wilson then took the feu to the south, and his feu contract contained a similar provision. He also began to build, but, when his building was roofed in, he became bankrupt. The defender, his trustee, proceeded to finish the building internally. The pursuer had not demanded from Wilson half the cost, but he lodged a claim in the sequestration to be ranked preferably therefor. The trustee disallowed the claim, and the pursuer appealed. It was held that he was entitled to a preferable ranking. Lord Cowan said:—"The feuar who has first built on his ground can demand from the second feuar . . . payment of the sum as being a real condition or burden affecting the subjects, and his right as inherently a preferable real claim can be made effectual as such."

IV.—Another point: there is a presumption that no payment has been made till use of the gable by permanent buildings has been taken. In Law *v.* Monteith and others, where no use whatever had previously been taken, the Lord-President M'Neill remarked:—"When the gable is ascertained to be a mutual gable for the use of an adjoining feu not yet built on, the inference is that the proportion of the expense effeiring to that adjoining feu has not yet been paid, unless there be a contract to the contrary;" and, in the same case, Lord Deas added—"They were bound to inquire and ascertain whether their authors had paid half the expense of the gable; otherwise it must be assumed that they knew they could not take advantage of it when they came to build without incurring the usual liability." In the

Glasgow Royal Infirmary *v.* Wylie and others, a use of the gable had been taken by the predecessors of the adjoining proprietors. When Sharp erected the tenement of three storeys, he took down the old wall of what was built on the adjoining stance—a one-storey building used as an office and a two-stalled stable—and replaced that wall with a mutual gable, the joists of the office and stable being let into the gable, and the flue into one of its vents. The contention of the defenders on this part of the case was that the use that had been proved was a bar to any claim against them when they came to make a more permanent use. The Court, however, would not give effect to any such contention: the natural inference (so it held) was the very reverse, the use of the gable by the defender's predecessor being by buildings of such a temporary nature that the defenders were bound to have satisfied themselves by inquiry as to the facts before purchase. The Lord-President Inglis gave the leading opinion, in which occurs this passage:—"No permanent buildings having yet been erected on the ground, it was, to say the least of it, most unlikely that the one-half of the mutual gable had been paid for—so unlikely certainly that the defenders were bound to have satisfied themselves by inquiry as to the facts."

V.—But any such presumption must needs yield to the fact, if the fact is otherwise; for whenever payment is made, the restriction of use is at an end, and the owner of the vacant ground is free to use the mutual gable when he chooses. When, therefore, payment has once been made by the proprietor of the vacant ground, payment cannot be demanded again by the builder's successor from the other's successor, and, were this second payment to be made in error, repetition of it would be obtained. In Robertson *v.* Scott (9th July, 1886, 13 R. 1127), Robertson feued from the Corporation of Edinburgh a piece of ground in Royal Crescent, Edinburgh, by feu charter, which contained a declaration that he should have right to the mutual gables of the adjoining houses, so far as they would have right to the same, on payment of half the expense of the said mutual gables to the persons entitled to claim the same. In erecting buildings on his feu, Robertson made use of the mutual gable of No. 10 of that crescent, The defender was proprietor of No. 10, and claimed payment of half the gable, which Robertson made good. Robertson, sometime afterwards, found out that the gable had been erected by Scott's author, and that the Corporation of Edinburgh had paid

Scott's author the price of the half thereof. Scott refused to repay Robertson the sum he had paid him, and accordingly Robertson raised an action against Scott for repetition. It was held that Scott was bound to refund the money. Scott argued that he had paid a full price for his house and gable, and that the claim did not emerge until his neighbour began to build and use the gable. True, as we shall shortly see, Scott could not have demanded payment sooner than when use of the gable was taken; yet, as I have already pointed out, what the builder of the gable has is a right of property—not in the whole gable but—only in the half built on his own feu, while the other half belongs to the neighbouring proprietor, though he did not build, the builder being entitled, however, to prevent his using it till payment has been made of his proportion of the cost. When payment has been made, there is, from that very time, no restriction of use.

Let me now touch upon the question as to the extent of the gable of which the adjoining proprietor is bound to pay the cost. Is it half of the whole gable, or only half of that portion of the gable which corresponds with the height to which he builds? The answer to this question, I think, depends upon whether there is a contract or not. If there be a contract binding him to pay the half, it seems to me, from a perusal of the cases, that the obligation is construed as meaning half of the whole gable, although he does not build to the full height of the gable. On the other hand, if there be no contract, it would appear that, the common law rule being one of recompense, the adjoining owner is bound to pay only half of that part of the gable corresponding with the height to which he builds. In Ness *v.* Ferrier (13th May, 1825, 4 S. 7), the trustees of Major Weir laid off a piece of ground at Drumsheugh for the purpose of feuing the same into lots according to a plan which showed that the houses in the centre and at each end of the street were to be higher than those adjacent to them. With each feuar they entered into articles of agreement whereby it was stipulated that the feuar of any lot or lots of the said ground upon building his house should have . . . recourse against the feuar of the lot adjoining such mutual gable . . . for one-half the expense thereof. The pursuer took one of the centre lots and built a house upon it of four storeys in height, while the defender took the lot which was

next to it and built a house of only three storeys. Ness claimed from Ferrier the value of one-half of the gable of four storeys, but Ferrier refused payment of the whole half, pleading that he was liable for one-half of only that part of it which corresponded to the height of his house, and alleging that, by the practice of Edinburgh, mutual gables were paid for according to the extent of the mutual possession. The Court, however, held that the clause in the articles formed the rule between the parties, and that no distinction was drawn between any one of the houses and another. On the other hand, Sanderson *v.* Geddes, which I shall afterwards cite, is a case dependent upon the common law, and the Lord Ordinary (Gifford) in that case said—"If the new building projected by the pursuer only uses part of the gable erected by the defender, it will be only half the value of the part so used which the pursuer will have to pay. For example, if pursuer's new tenement is only two storeys high, while gable is three storeys high, the pursuer will not have to pay anything for the unused portion of the gable." And this opinion was not gainsaid when the case went to the Inner House.

Of course, if either proprietor were to heighten the mutual gable for his own advantage, the other would not be bound to pay for any portion of the increment till he made use of it.

Passing from the extent of the payment to the time when payment falls to be made, I think that the solution of this question also is dependent upon whether there is a contract or not. If there be a contract, the terms of the contract will determine the point, and the presumption in such a case is in favour of immediate payment. If there be no contract, then the common law rule will regulate the matter, and payment is not due till use has been made of the gable; and the ground on which that rule rests, says Lord Shand in one case, is, "that, in the absence of special contract, the person using the gable has to give recompense for the use he has taken of it." With regard to cases of the former class, I may mention the following, which have already been cited:—Wallace *v.* Brown, where the obligation was to pay when the adjoining purchaser began to build on his own site, and where he became bankrupt before any erection had been commenced, the property, however, including a right to half of the gable, being sold by the trustee on his sequestrated estates; Ness *v.* Ferrier, where the obligation was to pay "as soon as the same

shall be feued"; Hunter *v.* Luke and others, where it was "one month after the said mutual gable and staircase have been commenced to be built, and where the conterminous lot has not been sold as soon as the said conterminous lot is sold"; Earl of Moray *v.* Aytoun and another, where it was "within one month from the date of the purchase of the adjoining feu." I should also allude to the case of Mackenzie *v.* Mackenzie, which I have not yet discussed (18th November, 1829, 8 S. 74), where the right of the party building the gable was to commence "within one month after said gables are completed if said adjoining lots are then feued, otherwise within one month after such adjoining lots are feued." In Mackenzie *v.* Mackenzie there was this peculiarity worth mentioning: The feu contracts, while providing that the feuar should have a claim against his neighbour for the expense of the half, did not impose any corresponding obligation to pay. Through the agency of defender, the pursuer took one of the building lots belonging to the superiors. The superiors kept printed drafts of their feu contracts. One of the stipulations in those drafts was that "the feuar shall have power to add 12 inches from the adjoining feu for each mutual gable, and shall be entitled to claim the expense of building one-half of said gables . . . from the feuars of the adjoining lots, . . . which shall be payable within one month after said gables are completed, if said adjoining lots are then feued, otherwise within one month after such adjoining lots are feued." The defender signed the printed draft; but, when the contract was engrossed, it was granted with consent of defender in favour of pursuer. The defender was a builder, and took the feu adjoining the pursuer's. The defender also acted as builder for the pursuer, and built the mutual gable. Defender did not erect a house, though it was averred by pursuer that part of defender's front wall was carried up by defender during the building of pursuer's house. The pursuer raised a summons against defender for half the cost, and the defender pled that he was not liable till he made use of the gable. The Court held that defender was liable, in respect that, though there was no obligation in his feu contract to pay, he was a consenter, and had also built the house. In passing, I may refer to a case that arose out of the preceding case, namely, Mackenzie *v.* Morrison's Trustees (November 23rd, 1830, 9 S. 44). Before the preceding case was adjudicated upon by the Inner House, to which it was reclaimed, the pursuer raised an action against the superiors, in respect that while they had

stipulated that the feuar was to have no claim against them for the expense of the mutual gable, but was to be entitled to claim half of that expense from the feuars of the adjoining lots, they had omitted to insert in the feu contract of the adjoining steading any obligation to pay. It was held that the superiors were liable under their clause of warrandice; and as the feuar failed to get expenses in his action against the co-feuar, because the latter was assoilzied as not being bound in his feu contract, though he was subjected in payment on a separate ground, the superiors were held liable in these expenses. In each of the cases with which we have been dealing under this head, it will be observed that a date of payment was stipulated. But in Sinclair *v.* Brown Brothers (17th October, 1882, 10 R. 45), which also depended on contract, no period of payment was mentioned. The pursuer had, in terms of his feu contract, erected a tenement on his feu in Caledonian Crescent, Edinburgh, with a mutual gable partly on his own feu and partly on the adjoining ground which came to be feued to defenders. In defenders' feu contract it was provided that they "shall be bound to pay to the said Peter Sinclair, or his successors, the one-half of the cost of erecting the said gable, which was thereafter to be mutual." It was held, for the reason given above, that the obligation, being unconditional, was immediately prestable. As regards cases where there is no contract, and where the common law rule has been held to be that no payment is due till use has been taken of the gable, you may refer to Rodger *v.* Russell, Law *v.* Monteith and others, and the Glasgow Royal Infirmary *v.* Wylie and others.

A question is not infrequently raised as to whether or not the mutual gable has been used so as to render the person liable in payment under the common law. In Mackenzie *v.* Mackenzie, a small strip, of about 18 inches in breadth, of the defender's front wall adjoining the pursuer's gable was carried up by the defender during the building of pursuer's house, which strip was averred by defender to have been built at pursuer's request and expense. If it had not been built at pursuer's request and expense, I doubt whether any such use would have created an obligation to pay at once half the expense of the gable. In Sinclair *v.* Brown Brothers, the defenders had erected a large drying shed, built of wood, but with an iron roof. The roof was supported by its own pillars, and only touched the gable

by a rhone in front. The Court held that the defenders had not made use of the gable, and that, had the time of payment been dependent on the rules of the common law, the defenders, by what they had done, would not have been subjected to payment. Take Lord Mure's opinion for example—"If it had depended on the rules of common law, I agree with your Lordship (Lord Inglis) in thinking that the proof of use would not have been sufficient to show that the gable had been here used in the sense in which such gables require to be used for building purposes in order to impose a liability to pay one-half of the price in respect of the use made of it."

It will be well, however, to point out, in case of misapprehension, that in the case of the Glasgow Royal Infirmary *v.* Wylie and others, while it was held that the use there of the mutual gable was not such as to elide the presumption that no payment had been made, the Lord-President Inglis took care to remark—"If the pursuers had said we shall not allow you to touch the gable in any way without first settling with us, there would have been a good deal to say in support of such a contention." You will remember I mentioned that, in that case, though the buildings were of a temporary nature, some joists had been put into the gable, and a flue into one of its vents.

Sometimes, too, the question arises whether a gable is a mutual gable or not. Let me give one or two instances in which such a question has arisen under rather peculiar circumstances. In Walker and others *v.* Shearer (4th February, 1870, 8 M. 494), the pursuers were the trustees of the U.P. Church in George Street, Aberdeen, and the defender was the owner of the adjoining property. The predecessors of both parties had acquired their ground from a common author by feu dispositions of the same date and similar in their conditions. One of the stipulations was that if the feuar should build on the march, the conterminous feuar should be entitled to take band in the same, on paying an equivalent for such privilege. Instead of adopting the ordinary course, as undoubtedly they could have done, of building a mutual gable partly on their own feu and partly on their neighbour's, the pursuer's predecessors built their gable entirely upon their own feu; but, as they were taken bound to build what was an equivalent to a mutual gable, the effect of the clause was to secure to the other feuar the privilege of a mutual gable,

if his neighbour built up to his march, though he built the gable entirely within his boundary; and, on paying the equivalent for his privilege, the other feuar was held entitled to take band in the usual way. In Sanderson *v.* Geddes (17th July, 1874, I.R. 1198), James Geddes was the proprietor of two thatched one-storey cottages in Channel Street, Galashiels. He died in 1858, leaving a settlement whereby his widow was entitled to the liferent of the two cottages, and on her death the westmost was to be conveyed to the defender and the other to the pursuer's author. The two cottages had a clay mutual gable, 4 feet thick, between them. The defender, with consent of the liferentrix, took down the westmost cottage, including the old gable, and erected a tenement of three storeys, with a new gable only 2 feet thick, yet built of stone and lime, and entirely on the ground pertaining to the other cottage. A question arose as to the rights of parties in this gable. The Court held that it was a mutual gable and that if the proprietor of the eastern house should avail himself of it in building a new tenement, he would be liable in one-half of the value of the part which he used, but that the proprietor of the other tenement would be bound to allow him a deduction for the value of that part of the *solum* of the old gable which he had appropriated. In Fraser *v.* Campbell (19th March, 1895, 22 R. 558), *A*, who had no title to the ground, built, in 1841, a house with the south gable apparently intended as a mutual gable, for on the south side of it were fireplaces and vents and band stones. In 1863 *B*, who had also no title, erected a house on the ground to the south of the other ground, and to a certain extent united his house with the south gable of *A*'s house. In 1878 *B* made use of one of the fireplaces in *A*'s south gable and boarded up the other. No objection to that course was taken by *A*. Both sites belonged to the same person. *A* did not acquire a title till 1878, when he obtained a feu charter which conveyed "that piece of ground on which is built a tenement of two storeys." *B* did not acquire a title till 1892. In his charter his subjects were described as bounded on the north by *A*'s house. In 1894 *A* intimated to *B* that he intended to make use of the fireplaces on the south wall of his house, and *B* applied for interdict against his so doing. It was held that the gable was not a mutual gable, but belonged entirely to *A*, who was not barred by acquiescence from asserting exclusive right to its use. Lord Rutherfurd Clark said, in reference to the conveyance to *A* :—"It is plain that the

ground on which the south gable stands is included within the conveyance"; and again—"The meaning of the titles, to my mind, is absolutely clear; and it is therefore, I think, inadmissible to control them by any inference to be drawn from the manner in which the gable was built, or in which it was used by the pursuer. . . . *A*'s title could not be limited by any use prior to its date. . . . I see no evidence of any agreement or consent to surrender any legal right, and I think that a use which had no justification in title must be ascribed to tolerance."

Now, what is one of the neighbours entitled to do to the mutual gable, and what is he not entitled to do without the consent of the other?

As regards repairs, not only is each proprietor bound not to injure the gable, but he is under obligation to see after its protection and preservation. If repair or reconstruction is rendered necessary through no fault of either of the parties, each may enforce the repair or reconstruction to be carried out, and his neighbour to contribute; and, if the matter were urgent, one proprietor would be justified in having the work executed without consulting his neighbour. During the repairs or reconstruction, each proprietor would have to bear the inevitable inconvenience attending such work without compensation. Of course, a different state of matters arises should the repairs or reconstruction be rendered necessary through the fault of one of the proprietors: in that case he is liable for all the expense and damage.

As regards alterations and additions, were a mutual gable common property, as some judges have held, the one proprietor could not do anything in the way of alteration or addition without the consent of the other. A mutual division wall is common property; and so, in Dow and Gordon *v.* Harvey (9th November, 1869, 8 M. 118), it was determined that one party was not entitled to heighten such a wall without the consent of the conterminous proprietor. In that case the Lord Justice-Clerk Moncreiff said—"It became a mutual wall, and from that moment one of the *pro indiviso* proprietors could not operate upon it without the consent of the other." But a mutual gable, as I have endeavoured to show, is not common property; hence the one feuar can, without the consent of his neighbour, operate upon it within certain limits. What are these limits? It seems to me that he can do on it anything, provided

that no injury or danger result to the gable or to his neighbour's property. In Walker and others *v.* Shearer, you will remember the feuar was entitled to take band. Evidence was led that taking band in Aberdeen included the right to insert band stones to the full width of the gable, and also the right of building on the top of the gable to the same extent; accordingly, the adjoining feuar was held not to have exceeded his rights in acting as he did. That case may be said to have been decided on the ground of contract. But I would now refer you to a case, the determination of which depended on the rules of the common law: I mean the case of Lamont *v.* Cumming (11th June, 1875, 2 R. 784). The pursuer and defender were proprietors of adjoining plots of ground in High Street, Renfrew, and the action was one of declarator that the defender had illegally interfered with the gable, by making openings therein to the depth of nearly the whole gable and resting therein joists of the floors of his new building, by turning a recess into a fireplace and carrying a flue from that fireplace through the gable, and by increasing the height of the gable. It was held that, though in doing so he had to remove for a time a few slates from the roof of his neighbour's house, defender had acted entirely within his rights. The Lord-President Inglis says—"He is entitled to have the wall made available for a gable for his house; and if he requires a fireplace and vents and does not find them, he is entitled to have them"; and again—"When the second builder comes to erect his house, if he constructs it in the ordinary way, he must insert joists and drive in dooks for the purpose of supporting the wood-work of the lathing. And were the second builder not entitled to heighten the gable it would end in this: that the first builder in a line of street, where there was no restriction in the titles, would settle for all time coming the utmost height to which the houses could be built. . . . Or suppose a two-storeyed house was built at one end of a street and three storeys at the other, as the houses advanced towards each other what a curious collision there would be. . . . The second builder may raise the wall to any height to which he wishes to build his own house, always provided that he does not injure the gable or his neighbour's property."

If there were injury or danger, or a reasonable dread of such, the adjoining proprietor should raise an action of interdict and damages.

In Lord Deas's opinion a distinction is drawn between operations

for purposes inherent in the nature of a gable and operations for purposes not so inherent. Thus he says, in the foregoing case, that wall presses could not be struck out without mutual consent. I question very much, however, whether there be any such distinction: for not only did the second Lord Curriehill, when Lord Ordinary, hold, in the case of Allan & Co. *v.* the Glasgow Union Railway Company, 1876, that the owner of a denuded gable may, without consent of his neighbour, use it for painting up business signs or advertisements; but also the Second Division held, in Todd *v.* Wilson (December 8th, 1894, 22 R., 172), that a proprietor of an upper flat in a tenement was entitled to connect it with the adjoining building, by cutting through the gable of the flat, in spite of the remonstrances of the owner of the street flat, who could not allege that the operations would result in any injury to his chimneys. And the *ratio decidendi* was this: just as the true view in the case of (shall I call them) lateral proprietors in a mutual gable is that each is proprietor of the half built on his ground with a common interest in the whole, so in the case of proprietors of different flats of a tenement, each is proprietor of the gable *quoad* his flat, with a common interest in the whole.

I may be allowed to conclude with the advice, that before operations of any moment be done on a mutual gable, application for warrant to carry them out should be made to the Dean of Guild Court, all parties interested being called to the action.

XIV.—A DEMONSTRATION ON THE X RAYS.

A Resumé of Experiments since his former Demonstration before the Society. By DR. JOHN MACINTYRE, F.R.S.E.

[Read before the Society, 17th March, 1897.]

Little more than a year ago I showed what might then have been called a comparatively simple and primitive apparatus for taking photographs by means of the X rays. The subject being one of interest, and having rapidly developed, the Council of the Society were good enough to request me to give a second demonstration before the close of last session. It was found ultimately that this could not be arranged, but it was agreed that another demonstration should be given during the present session, and I have much pleasure now in acknowledging the honour conferred upon me, and to thank the Council for the courtesy and kindness shown in making the necessary arrangements.

Some of you who were present at the last demonstration may remember that I showed batteries as the source of energy, transformers including induction and Tesla coils, and a number of Crookes' tubes. Afterwards the practical working of the apparatus was referred to, and some photographs were thrown upon the screen. I make this reference because it is perhaps better that to-night's demonstration should be something of a resumé of experimental research carried out since then, and to some extent the same arrangement will be pursued in dealing with the subject. It may be as well at once to make the further explanation that the work to be referred to has been mainly in the direction of the application of the rays in different branches of art and science, although I am not at all insensible of the vast interest attached to the subject when studied from the purely physical standpoint. We must ever remember, however wide the range of application, that the discovery originally came from the physical laboratory.

Before beginning to speak of the separate parts of the apparatus, our thoughts naturally turn to those methods which have been found best suited for the production of X rays. It can at once be said that the commonest way is by means of a transformer and Crookes' tube. It does not necessarily follow, however, that there is only one way of producing the X rays. For example, it will be within the recollection of many present that Lord Blythswood was able at our last demonstration to show some photographs taken by means of his great static machine and without a Crookes' tube at all. These early experiments were confirmed and published in *Nature* later last year. Other experimenters, including myself, have been able to obtain photographs of metallic objects without the Crookes' tube. I was never able, however, to satisfy myself that these were the results of any actinic action produced by means of the X rays. On the contrary, when they were subjected to severe tests, as suggested by Lord Kelvin, both with the induction coil and also a large static machine, the evidence rather tended to show that the picture was due to the passage of an electric force through the wooden and other coverings of the photographic film. It is not unlikely that ordinary light was in some way brought to bear upon the silver after the electricity had passed through the materials which enclosed it. These results do not, however, conflict in the least with those obtained by Lord Blythswood, because the conditions under which they were obtained were different. It is useful, however, to recall these facts, and to remember that at least one experimenter has stated that in his opinion it is possible to generate X rays in sufficient quantity to give a photograph of a metallic object, if not of hard or soft tissues, without the use of a Crookes' tube. That there is even diversity of opinion about the best apparatus can be gathered from the experimenters who prefer the alternating current and Tesla coil; some even go the length of predicting that the last-mentioned will in the end supersede our present methods. Nevertheless, I think we may state the position of matters fairly by saying that the best work which has been done in this country or on the Continent has been the result of using the induction coil and a well-constructed tube.

If there be one thing which a lecturer on this subject should make clear, it is the fact that all the credit of *seeing shadows*, as well as making permanent records by means of photography, falls

to Professor Röntgen himself. The world at first was startled with the idea of photographs of the hard structures of the body, and this one idea seemed to overshadow all others; but Professor Röntgen not only photographed the bones of his hand, but he first saw them as shadows on a barium-platino-cyanide screen. In other words, direct vision was discovered previous to the photographic record. What the original discoverer left for others to do was the improvement of the methods for producing the X rays, and this has been and will for long continue to be enough. Considerable progress during the past year has been made, but if there be one thing more impressed upon us than another, it is the absolute necessity of the utmost care in experimental research connected with every detail. We can afford to overlook nothing, and every part of the apparatus will yet require great development ere satisfactory results are obtained.

Apparatus.

Currents.—Further experience has confirmed the view expressed last year that the street main is by far the best source of the electricity. Where this cannot be got, we must have recourse to secondary or primary batteries—preferably the latter. A considerable number of workers with batteries who have communicated with me on this subject, and who have afterwards employed the current from the main controlled by means of the rheostat, have reported favourably upon the better results obtained, owing to constancy of current and range.

Coils.—There can be no question as to the excellence of the Apps or Apps-Newton coils, although many others are now in the market. I use both, but largely also one of German make, the advantages of which lie in the thickness of the primary wire. By this means one is able to send heavy currents through it without risk to the coil, a fact of the greatest value, particularly in surgical work in large hospitals, where they are now in constant use for a long period daily. Instrument makers do not seem to be altogether agreed as to the advantages of a great many sections. English coils, which are very compact, are constructed with a large number—an 18-inch spark coil probably containing as many as 150 sections. In case of injury to the coil, it can easily be seen how much better it would be to remove one or more of these, than in the case of a German coil of the same size, which often only contains from 30 to 40 sections.

Condensers.—The condenser is a very important part of our apparatus, and while it may be made up with the coil usually in the base, it may be kept separate. It is important that the making of the break of the circuit should be sudden, and this part of the apparatus aids this by preventing the spark of the extra current due to self-induction in the primary circuit passing across the interrupter. It is important that the condenser should be looked to occasionally, because it may break down as a result of too strong currents, and the spark is in many cases found to be improved by a well-made and suitable condenser. If put at our disposal, extra condensers are sometimes exceedingly useful.

Interrupters.—When we are dealing with interrupters, it may be said at once that the common vibrator, such as we find in the Apps-Newton coil, or the ordinary spring, is an extremely practical and efficient form, and certainly it does very well, at least, in the smaller coils. The necessity of careful attention to every detail in the apparatus for the production or application of the X rays is well exemplified in the interrupter. Anyone can satisfy oneself very easily that a slight variation in the tension of the spring will not only alter the length of the spark, but also change the electrical excitability of the cathode, and so influence the remaining molecules within the tube, and consequently the X rays. These changes can be beautifully shown on the fluorescent screen.

The first important point which attracted my attention to the question of the interrupters was the different effects got by using a mercury interrupter, instead of the ordinary platinum spring. A large number of experiments were made, in which an ampère-meter and volt-meter were placed in circuit to register the exact current across the terminals, and also through the primary coil, and again while the interrupter was in action. It was found, for example, that with the same current passing to the coil and using the spring interrupter, the ampère-meter might register 2, 3, or 4 ampères while in action, and with the mercury form it might be as high as 7 or 8 during the exposure of a photograph or examination of shadows on the fluorescent screen. Advantage was taken of this, as will be seen further on, to reduce the time of exposure and increase the brilliancy of the fluorescent screen. The particular form of mercury interrupter employed was the one attached to my German coil, an upright spring carrying a transverse beam, at one end of which was a steel rod dipping into the mercury, and at the other a piece of soft metal to be attracted

to the core. This naturally drew down one end of the bar and lifted the rod out of the mercury. The moment the contact was broken and demagnetisation had taken place, the spring sent the rod into the mercury, and so the contact was again made. With one flash of the tube, due to one vibration of the coil, as will be seen afterwards, some photographs were obtained, and with ten flashes an excellent negative of the fingers was the result. The time taken for the spring to act between the flashes was too great, and, consequently, I have modified this by employing a mechanical interrupter driven by a small electro-motor. In this way 2,000 or 3,000 contacts per minute can be obtained. It is just possible, however, that there is not time for the proper magnetisation of the core under these circumstances, and that, therefore, the results may yet be correspondingly increased. In using a mercury interrupter, it may be as well to point out that Mr. Apps strongly recommends an amalgam of mercury and platinum, instead of mercury, at the bottom of a vessel, suitably arranged to have a large column of alcohol above the amalgam. By this means sparking and oxidation are considerably reduced. The disadvantages, however, of the amalgam or the mercury lie in the tendency to oxidation, and, consequently, I am having a mechanical motor constructed where the "make" is made between platinum points. This will also be driven by an electro-motor, the speed ranging from 250 to 4,000 per minute. It is hoped that with some such arrangement still better results will be obtained, and many experimenters, I feel quite sure, do not obtain the best results owing to imperfectly-made interrupters.

Measurement of Currents.—It is customary to measure the current according to the distance that sparks pass across the gap between the discharge rods in air. While this is a valuable factor to note, it must be evident that the efficiency of the discharge must never be forgotten. Thus a continuous strong current is of greater advantage to us than a jerky, small, zig-zag spark of equal length. It is also of importance to note the ampère of the current passing to the primary coil, likewise the voltage, and still more so to register the exact current passing at the time the coil is in action. I employ Lord Kelvin's ampère-meter, and, by regulating the interrupter by means of a rheostat, the needle of the meter may be kept very much at the same point. Thus, for comparison, one is able to repeat experiment after experiment approximately under the same conditions.

Vacuum Tubes.—These are probably by far the most important part of our apparatus. Many forms were tried, but Mr. Herbert Jackson, of King's College, London, has laid every worker under a great obligation by the selection of the now well-known focus tube. This well-known physicist, long familiar with experimental research in the electric discharges in vacua, soon decided upon the best kind of tube. I should like to put it on record that many months before Professor Röntgen's observations, Mr. Jackson, using the same focus tube as is now employed, and exciting fluorescence on a barium-platino-cyanide and other fluorescent screens, actually saw shadows similar to those observed by Professor Röntgen, but he is the first to acknowledge the great difference in the explanation of the phenomena, particularly in all that relates to the difference in refrangibility. No one is entitled to the discovery but Professor Röntgen, but it is of interest to note that the phenomena had been observed by another before Professor Röntgen. In this form of the tube, which it is only fair to say is but a modification of one designed by Crookes, and described in 1879, the cathode is a concave aluminium disc. The residual molecules of air are, as interpreted by Crookes, Lord Kelvin, and others, impelled by some force from the cathode onwards. It is assumed by some that this force is due to the negatively-charged molecules being repelled in straight lines from the cathode, itself positively charged, but we may as well leave this debatable point alone. Crookes showed long ago, however, that if a piece of platinum be placed in front of a concave disc, these lines would focus at a point, causing the metal to become red hot.

In the focus tube at present in use the anode, or, better still, the anti-cathode, is usually made of some metal, commonly platinum, and is placed near to, but a little outside of, that focus. The theory is that, as the molecules fall upon this plate, the X rays are generated, and that these start from this point, passing in lines so as to form a cone, the apex of which is the point where the focussed molecules impinge. It may be pointed out here that it is not necessary that the piece of metal or other substance placed in front of the molecules should be in contact with the positive pole. The anode may be at another part of the tube, and the molecules may simply fall upon a substance placed in front of it, and hence the value of the term anti-cathode. There is something yet to be determined about the position of the anode. Months

ago, as described in *Nature*, I made an adjustable anode for approximation to, or withdrawal from, the cathode, and by tapping the tube one could adjust it for the best results. Subsequent experiment showed, as was also pointed out by Wright and others, that greater current was required than when the distance from each other was increased.

It is customary in drawings to explain the theory of the passage of the molecules, to draw the lines of force as if they were rays of light passing from the concave reflector, crossing each other at the focal point, and continuing in straight lines. This is not quite the case, however, because at a lower exhaustion of the tube a bluish cone is seen coming from the base at the cathode, and another, with its apex, joining that of the upper one. As the vacuum increases, the lower cone changes, and ultimately disappears into a straight line. I will excite a Crookes' tube, and it will be seen to be a green colour, but this must not be confounded with the X rays. Some of the X rays passing through the glass excite fluorescence, owing to its composition, and give the green colour in the German glass, but all the rays are not stopped, and it is those which still get through the glass and pass towards the photographic plate, or fluorescent screen, that we make use of.

During the past year I had a number of tubes made of different thicknesses, and specimens of many forms were sent to me on trial by different opticians; but while a very thin glass is of use in stopping fewer X rays, still, as we frequently heat them for purposes afterwards to be described, too thin a glass is apt to break under the severe strain, and be destroyed. When the glass gets into a highly electrified condition the tube is apt to burst, and, curiously enough, I have seen one sent into minute threads, like spun glass, *five minutes after* the mercury interrupter had ceased to work. While the tube may be made of dark glass, so as to exclude the green ordinary light (one of the German tubes of this pattern was sent to me by way of experiment), I prefer to exclude the whole of the ordinary light from the tube by means of a special stand, to be described further on. As a result of further experiment, my experience has been the common one, that either the large tubular form, or part of it blown out into a globe, gives, with the terminals far apart, the best results. That the form of tube is not without influence is seen from the fact that in certain tubes made for me, the cathode was placed too far inside of the bulb, or too high above it in the

tube. My experience is that the best tubes have the cathode in a line with the curve of the globe, and this had also been confirmed by adjustable cathodes suggested to me by Mr. Newton.

Another point of importance in saving tubes is to have the leads to the interior of the tube of a thick metallic wire, say, of aluminium. Further, the ends of the tube should be capped with metal, and a strong loop of wire, not liable to break, should be at our disposal for attaching the conducting wires from the coil. Some have tried double cathodes; of these I have had no experience. In other tubes, such as the Berlin one, the connecting wire of the metal, which is placed in front of the cathode, is also joined up to the positive pole. Other experimenters have tried double anodes.

The size of the cathode is probably not without value; at least, in the earlier and inferior forms of the Jackson tube, the cathode was smaller. Whether it be due to better exhaustion or not, my experience is that Newton's improved tubes, which have larger-sized bulbs and larger cathodes, give better results. The anode, or the anti-cathode (for it need not be, as we have seen, in connection with the positive pole), may be made of different metals. As a rule, those of high atomic weight are the most efficient. Platinum is a common one, but I have also tried palladium, aluminium, &c., and from experiment I have found also that the anode should be large, not only to prevent heating, but occasionally the cathode changes its position, and the fine line above the focal point, already referred to, may pass it altogether. The surface should be smooth, and inclined at an angle of 45°.

It is of great importance to prevent the anode heating, and I have had a considerable number of anodes made of different thicknesses; one of the best of this construction was made for my friend Dr. Fleming, and in this case the heating of the anode has been greatly reduced. The penetrator tube made by Messrs. Watson, London, has been sent to me to test, and it deserves high commendation. It would be unfair to say that it is better than any supplied by others or made for myself, but it is fair to say that, while most of my results were obtained by other tubes, I have not had as much experience with Watson's as with others.

The most important point has yet to be dealt with, and that is the vacuum. Theoretically speaking, the ideal tube would

have the vacuum to suit a particular coil, but this is difficult for those who have not got the necessary apparatus for exhausting tubes. There are many curious phenomena to be observed in connection with Crookes' tubes, and probably not the least of these is the alteration in the vacuum as the tube is used. For example, a tube that sometimes comes from the maker with a somewhat low vacuum becomes all right after a little use, or even after letting it alone for a few days. The most common variation is found to be a rise of the vacuum as the tube is used, or, at least, an apparent difficulty in sending the current through it. If the vacuum should get too high, there are several ways of bringing it back to its original condition; the commonest way, perhaps, in this country at least, is to heat the tube by means of a Bunsen or spirit lamp. Another is to run a weak current in the opposite direction for some time, and the third, a very ingenious one, is shown in Watson's newest penetrator tube, where a smaller glass tube communicates with the bulb, and contains a small piece of palladium. When this small tube is heated, a few molecules of gas are given off, and, passing into the bulb, correct the vacuum. When using the tube, it is better always to push in the discharge rods of the coil to such a distance that a little increase of the vacuum will cause sparks to fly across the space in air between the two. This sparking indicates at once any alteration in the vacuum, and directs the attention of the operator to the necessity of correcting it by one of the before-mentioned means. It serves another purpose, namely, that of keeping all the factors during a series of experiments as nearly the same as possible. We have seen how necessary it is to have the current registered and kept constant when working, and so this control of the vacuum adds another constant, or nearly constant, factor for comparison in successive experiments. Having considered all the points that have been mentioned, I had large tubes constructed, the bulb of each measured 5 inches, and the cathode 1¾ inches in diameter, the object being to get large tubes with high vacua especially suited for large coils. The instrument makers found this a severe task, and it seemed as if our experiments were to be stopped meantime.

Through the kindness of Professor Barr, I was able to use a new form of pump invented by himself and Professor Stroud. The experiments in this direction were amongst the most serious yet undertaken by me in connection with this subject. This pump is

exceedingly simple, and with a small tube the vacuum is obtained with great rapidity. We look forward to the perfection of it to give us higher vacua in the larger tubes with the same degree of rapidity. It is right for me to say, however, that one of these large tubes was exhausted, after great labour, by means of the ordinary glass mercury pump. It was sent to me by Messrs. Baird & Tatlock to test, and, as far as I know, the vacuum in this large tube is the highest yet obtained for X rays.

Stands.—I have had the ordinary chemical stand enlarged and modified to give universal movements for holding the Crookes' tube. The one before you is six feet high, mounted on glass insulating feet, so that we may examine any part of the body in the erect posture or recumbent position. One part of interest is the arrangement for excluding all the ordinary light of the tube. It is merely the ends of a square box held together by insulators of glass, and the rest covered with velvet. The tube is inside of this, so that while examining the fluorescent screen in the room no light is seen. This I consider a better method than by making the tube of dark glass.

Fluorescent Screens.—When this discovery was first announced the attention of the world was attracted to the photographic aspect of the question, but those who had the opportunity of reading Professor Röntgen's original paper saw that the discoverer had done more for us than give us a "new photography." The bones of the hand were first seen in shadow on the fluorescent screen, and the photograph was the result of succeeding experiments. Moreover, other workers, as we know, had taken photographs by means of invisible rays before Röntgen. I would not have made this explanation had it not been that some journals, even scientific ones, in reviewing the year's work repeated the statement that a step had been made in advance when certain experimenters had brought out an instrument called the cryptoscope. The difference between the cryptoscope and Professor Röntgen's fluorescent screen is simply that, instead of using a dark room, a dark box is used in the open room. The method is not as efficient, and it would be manifestly unfair to take any credit to which Professor Röntgen is entitled on the question of direct vision as well as the photography.

Immediately after last year's demonstration, through the kindness of Lord Blythswood, some barium-platino-cyanide was placed at my disposal. My first attempt at fluorescent screens was

simply a microscopic eye-piece out of which the lenses had been taken, and a small quantity of the salt had been placed on a piece of paper at the end of the body of the tube, covered in with a piece of black paper. Only the faintest shadows could be seen of a metallic moving object in the front of this apparatus. Within a month from that time, as a result of experimental research, including the thickness of the coating of the salt, the proper size of the crystals, &c., I was able to see lesions in the extremities, and shadows of the bones of the arm and the leg could be seen, and shortly afterwards a foreign body was detected within the chest of a young patient.

These earlier screens proved so satisfactory that I could, at this early period, see movements thought, and subsequently proved, to be the movements of the heart within the thoracic cavity of an adult, the only difference in the subsequent screens being the making of a larger size of screen so as to see the movements of the organ itself, the diaphragm, as well as ribs, spine, and other hard parts of the surrounding thoracic cavity. Like other experimenters, I made a great many screens of different salts, including potassium-platino-cyanide, barium-platino-cyanide, lithium-rubidium-platino-cyanide, some of the silver salts, and the calcium tungstate, as recommended by Mr. Edison. From his knowledge of this department, Mr. Jackson was at once able to say that his past experience led him to select the potassium-cyanide salt as giving the greatest luminosity, and that is certainly true, but there are times when the barium salts seem to me to cast for some surgical purposes a better shadow of the deeper structures of the body. At any rate, both are useful. Lithium-rubidium-platino-cyanide is also good, but, whether it be due to the manner in which the crystals of the calcium tungstate are prepared or not, I regret to say that in our hands it has been found inferior to others. The methods by which these earlier screens were made by me are described in *The Lancet* and *Nature* of the first half of last year. It may be pointed out, however, that no perfect screen as yet exists in the sense of being able to obtain the maximum results. Four screens in front of each other, one foot apart, may be illumined in a dark room, and yet X rays are still passing through in sufficient quantity to show the bones distinctly on the last screen. When the apparatus is in the best working order the penetration is found to be very great. For example, one, two, or three adult bodies will not completely obstruct the rays.

I have sent them across a 16-feet room, and through a thick wooden door or partition, coated on both sides with lead paint, in sufficient strength to show the contents of a box in the next room.

Another important point in connection with these screens is the effect of the rays upon them. The action upon the salt is not transient as was at first thought. I have distinctly seen an image of a metal ring on a screen a week after it had been kept in the dark. These screens, I have reason further to suspect, are acted upon by ordinary light, and, to preserve them, it is just possible that it might be useful to keep the screens in the dark when not in actual use.

Application of the X Rays.

Photographic.—It is not always sufficient to enclose the photographic plate in a dark envelope, and place it below an object to be photographed, especially when we are dealing with animal tissues of considerable thickness. From what has already been said, it will be understood that the X rays are supposed to pass out of the tube in the form of a cone, the focus being at a particular point within the tube. As they pass to the photographic plate (or, it may be, the fluorescent screen), it is evident that, if the object be placed some distance from the latter, shadows will be cast, and the further the object from the plate the worse will be the definition. Conversely, it follows that the nearer we get the object to the plate, the better will be the definition. Some parts, however, of the human body are so situated that it is impossible to get them close to the photographic plate or screen. We must therefore consider the following points of importance:—firstly, penetration; secondly, definition; thirdly, the necessity of omitting in photographs, or on screens, shadows of other organs, in front or behind, which are not required, and which would necessarily obscure the one object to be photographed. In other words, it is necessary sometimes to take photographs in different planes of the body with a view to obtaining a picture of one part while omitting structures lying in its vicinity. For penetration of the deeper structures the most powerful apparatus is necessary, and very few of the deeper tissues of the body can be photographed rapidly, or seen to advantage on the fluorescent screen, with less than a 10-inch spark coil thoroughly excited. It need hardly be added that the

tube and every other part of the apparatus must be of the best make and in thoroughly good order. When we come to the question of definition, the further we remove the tube from the body the less will we be troubled with the peripheral rays, and the more correct will be the image formed by the central ones;—that is to say, there is a relationship between the distance of the object from the plate or screen and the point at which the tube ought to be situated. Generally speaking, the nearer the object to the plate the closer can we afford to place the focus tube, which, of course, is an advantage where we wish brilliant illumination or rapid photographs, as distance naturally affects these. When we come to the question of photographing objects in a particular plane of the body, we have to remember that what is a disadvantage in the ordinary focus tube, owing to the cone-shaped arrangement of the rays, here proves of service.

Let me give you an example:—If a plate be placed on the outside of the right side of this skull, and the focus tube close to the other side, an accurate image of the bones lying near to the plate will be got, while that representing the bones on the other side will be so diffuse as to be practically non-existent. We may thus photograph the inside of the skull on the one side, and omit that of the bones on the other, although the rays are passing through all. Again, placing the body face downwards, and putting the tube the proper distance, the ribs and the sternum will be well-defined, and the spine lost. On the other hand, if the person be lying on the back, the spine will be photographed, and the interior part of the chest will not come out on the plate. It need hardly be said, as mentioned already in the question of definition, that if the tube be removed too far from the body, and sufficient time be given to act upon the sensitive plate, both the front and the back of the chest would be obtained. It will also be seen that if we take two photographs at different points, so as to cast oblique shadows, a relationship will exist between the distance between the two images and the distance between the two points at which the focus tubes were placed. In this way we may get an idea of the distance at which the organ lies from the surface.

HARD AND SOFT TISSUES.

Objects oppose the rays according to their density. It naturally follows that bone is more easily photographed or seen on the

fluorescent screen than soft tissue. Nevertheless, we may take advantage of different densities of organs, and, by correct exposures and careful regulation of the distance of the tube from the plate, obtain photographs of some of the soft tissues of the body. Thus, by placing the patient face downwards a well-defined image of the heart can be got, or even an enlarged blood-vessel, such as an aneurism. The larynx has also been well defined through the neck, showing the base of the tongue and pharyngeal cavity, and the thoracic wall of bony tissue with the diaphragm and cardiac area, can also be brought out in such a way as to show the conical spaces corresponding to where the lung tissue lies. In a few instances cases of condensation of the lung—that is to say, a different density at the apex of the lung—have been made out. If we try the lower animals (especially in the dead subject), the viscera are easily photographed, and it need hardly be pointed out that foreign bodies in most parts of the body may be easily seen or photographed; in some organs even calculi, in a few instances, have been detected.

Different Kinds of X Rays.

Amongst the best and earliest workers in this department Professor J. J. Thomson must take rank, and he has come to the conclusion that the X rays are not all of one kind. Following out this inquiry, I made a series of experiments with regard to the effect upon the screen while keeping the tube at different vacua. Whether it be a matter of degree or quality in the rays, no one can doubt that under certain conditions of the tube the bones of the hand show well, while the soft tissues are almost imperceptible; at other times many of the soft tissues may be brought out, and the bones appear much less marked. It follows from this that the condition of the tube is of the utmost importance in photographing the soft tissues of the body, and careful attention to this had much to do with the successful demonstration of many of the soft tissues and internal organs which were photographed during the past year.

Recent Developments.

Before closing, I may be allowed to refer to two sets of experiments of which more may be said in the future. It occurred to me that it might be useful to reduce the size of the image to be

photographed by means of the photographic camera. All light in the room was excluded by the arrangement already referred to, the light turned off, and an image of the hand was caused to fall upon the fluorescent platino-cyanide screen. An ordinary camera was placed in front, and the screen focused on the ground glass. A few minutes' exposure with an ordinary photographic plate sufficed to give an image of the bones of the hand, reduced in the proportion of 12 to 2 inches. As yet, of course, the difficulties here are in the length of exposure necessary, but with increased force this may be materially reduced. One curious result was got with this experiment. The first time a plate was tried, not only did we get a reduced image of the hand produced by converging rays of ordinary light from the screen, but on the same plate an enlarged picture of the front of the camera was got, which was due to diverging X rays. Subsequent results were successfully carried out by putting a sheet of lead in front of the camera. This, combined with the lens, stopped all the X rays, while the ordinary light was focused by means of the lens. An important observation was here made, and some information obtained. It was evident from this experiment that the screen was not stopping all the X rays, and it was from this observation that I placed four screens in front of each other to demonstrate that the rays went through and in sufficient quantity to give a shadow of the bones on the fourth. By increasing the thickness of the fluorescent salt, likewise attending to the size of the crystals, much has been done as the result of this experiment to increase the efficiency of the fluorescent screen, and so proportionately to further the study of direct vision.

X RAY CINEMATOGRAPHIC PHOTOGRAPHS OF MOVING BODIES.

The last experiment to which I will allude is that of attempting to photograph the movements of parts of the body by means of the cinematograph. Controlling the limbs of a frog by mechanical means, and putting the apparatus into the most efficient condition to obtain powerful rays and quick actinic action, a rapid series of photographs were obtained of the bones of the leg, surrounded by the soft tissues. I have here a film with several hundred pictures of this object in different conditions. When these are passed through the cinematograph in the usual way, the movements of the joints are demonstrated. Combining the last two conditions

of screen and camera, it is not impossible that many of the movements of the deeper organs of the body, say, for example, those of the heart, will some day be demonstrated to large audiences.

From what I have said at an earlier part of the demonstration it will be obvious that all our present methods and ideas may suddenly be changed. It may be by means of the Tesla coil, or it may be without the aid of the Crookes' tube, or some other suggestion, there will be no necessity for pushing the present methods beyond certain limits. We are, however, in the fortunate position at present of knowing that we have not yet reached these limits. I am at present having a coil constructed to give 18 to 20 inches spark, a range probably beyond the power of our present tubes. If we are successful in getting more powerful tubes, then we must increase the transformers. Suppose we come, by-and-by, to reach the limits with our present apparatus, without attaining our object, then other methods must be found.

When Professor Röntgen made his original observation, he was in doubt as to what these rays really were, and thinking they might be the longitudinal rays in ether so long ago predicted by Lord Kelvin as likely to exist, he deemed it advisable to call them X or unknown rays. It is impossible here to discuss what the Röntgen rays really are, but perhaps it is permissible to say that a large number of physicists are now inclined to take the view that, after all, we are dealing with transverse vibrations in ether far away removed from and beyond the ultra-violet with which we have been long familiar. If this be so, there is no reason to assume that a gap exists between the ultra-violet and the X rays; and, indeed, Becquerel has lately given us proof of the existence of rays emanating from uranium and its salts which suggests the possibility of some of these having already been discovered. Whether this be true or not, the thought has been put into the minds of men that in the future it will be possible to demonstrate by X, or other rays, structures which have hitherto been considered beyond the appreciation of their senses. A little consideration of these suggestions impresses us with the thought of how useless it is in the present state of our knowledge to minimise or exaggerate the importance of the subject. Last year I contented myself by stating precisely what had been done, and to-night I prefer to place again before you some advances that have been made during the year, believing,

as I do, that no adverse criticism from any source can now arrest investigation in this new and great field of scientific research.

The following were shown at the Demonstration:—

Various batteries, English and German induction coils, rheostats, volt and ampère-meters, spring mercurial and electro-motor interrupters, Crookes' tubes of different shapes and sizes at high vacuum, stands specially designed for holding the tubes and excluding all ordinary light, fluorescent screens, cryptoscopes, simple and binocular, &c.

Photographs on plates, or by the magic lantern screen, of different parts of the skeleton, showing the cavities of the body, including the spinal column, pelvis, interior of the cranium, bones of the head, face, and all the joints of the body.

Instantaneous photographs of the extremities, animal kingdom, &c.

Photographs of the soft tissues, such as the pharynx, larynx, chest, heart, diaphragm, and other viscera.

Foreign bodies in the cavities of the body and in the extremities.

An X ray film was passed through the cinematograph showing the movements of the leg of a frog on the screen.

XV.—*Experiments with Röntgen Rays, Ultra-Violet Light, and Uranium.* By J. Carruthers Beattie, D.Sc., F.R.S.E., 1851 Exhibition Science Scholar, Research Fellow of the University of Glasgow; and M. Smoluchowski de Smolan, Ph.D., Research Fellow of the University of Glasgow.

[Read before the Society, 14th April, 1897.]

Before entering on the subject proper of our paper we shall show you some uranium photographs. The first photographs of this nature were taken about a year ago by Professor Becquerel. An account of the manner of taking them is given in *Comptes Rendus* for last year. The method which we employed is similar to that of Becquerel. We took an ordinary photographic plate and laid it in a dark room. On this plate we laid the object or objects to be photographed, and on these again we placed a piece of very pure uranium in the form of a disc, about 5·5 cms. in diameter and about 0·5 cms. in thickness. The time of exposure was usually about twelve hours. You see on the screen the first photograph which we took in this way. The outline of the uranium disc appears white. Then you will see a dark strip running across it, with the letter **Z** in the middle. This represents a strip of zinc with the letter **Z** cut out of it. This specimen of zinc, you will notice, is nearly opaque to the uranium rays. Adjoining the zinc strip you see a second strip almost as white as the outline of the uranium disc. This represents a strip of aluminium. You cannot see in it the letter **A** which we cut out of it. The aluminium is so transparent to the uranium rays that the part of the photographic plate covered by it is influenced almost to the same extent as the part directly opposite the uranium. A shorter exposure would have brought out an effect similar to that in the case of the zinc plate. The third strip is again fairly bright. In it you can see the letter **C**, just a little brighter than the surrounding part. This was a strip of copper which, you see, is also transparent to the uranium rays, though not so much so as the aluminium. The last strip is quite dark, with a bright **L** in it. This was a strip of

lead, which is opaque to the uranium rays. Evidently, with sufficient care, we could, in this way, determine the transparency of different metals to the uranium rays. This second slide shows you a photograph of a key. The third one is a photograph of four coins.

We shall proceed now to our paper proper.

The fact that air can be made conductive by ultra-violet light was shown some time ago by Righi, Elster, Geitel, and others. J. J. Thomson was one of the first to show that the Röntgen rays made air conductive. Becquerel showed that uranium and several of its salts had the same effect.

We have made a number of experiments under Lord Kelvin's direction, and, with his help, on the conductance produced in air by the above agents. We shall here give you only the chief results of our work. A more detailed account will be found in a paper to the Royal Society of Edinburgh by Kelvin, Beattie, and Smolan.

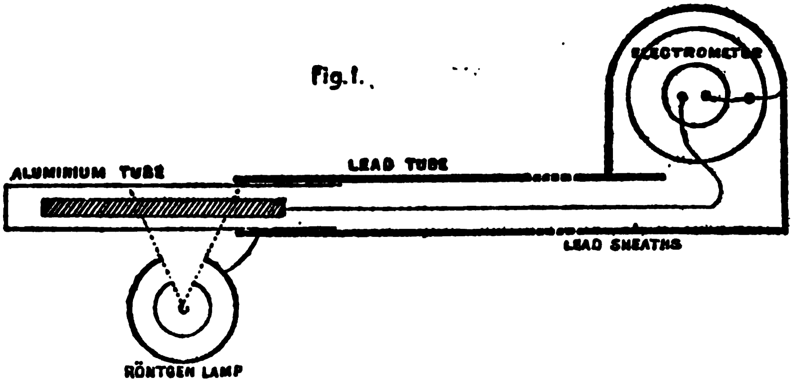
We have used two methods to measure the conductance produced—the first for low voltages up to two or three volts, the second for higher voltages up to 2,000 volts.

In the first method we connected the charged metal directly to the insulated terminal of a quadrant electrometer. With Röntgen rays this charged metal was insulated on paraffin blocks, and placed in an aluminium cylinder connected to the case of the electrometer. The wire leading from the insulated metal to the electrometer was carefully guarded against inductive effects. To produce the Röntgen rays we used a vacuum vessel, with an oblique platinum plate (Jackson pattern). It was surrounded by a lead cylinder connected to the case of the electrometer. In the side of this cylinder there was a window, 2·5 cms. broad and 5 cms. high, which could be screened or unscreened as desired. When a screen was used it was always connected to the case of the electrometer. The Röntgen lamp was placed a few centimetres from the aluminium cylinder (see Fig. 1). We found that, when the insulated metal was charged to a potential of two or three volts, it lost its charge, whether positive or negative, in about five seconds. So far as we could decide from our experiments, positive and negative charges leaked away with equal facility, if we reckon the charges, not from the metallic-zero* of

* The metallic-zero is the reading obtained when the two pairs of quadrants are in metallic connection.

the electrometer, but from a point at which the electrometer reading remained steady, with the two pairs of quadrants insulated,

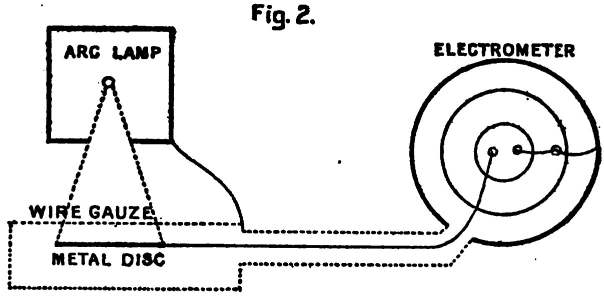
Fig. 1.



and the rays falling on the insulated metal surrounded by the aluminium, which was transparent to them. This point, which we shall call the rays-zero, was different for different metals insulated inside the aluminium cylinder.

In the experiments with ultra-violet light we placed the insulated metal inside a cage of brass wire gauze, which was connected to the case of the electrometer. The ultra-violet light was obtained from an arc-lamp (see Fig. 2). We found that when the

Fig. 2.



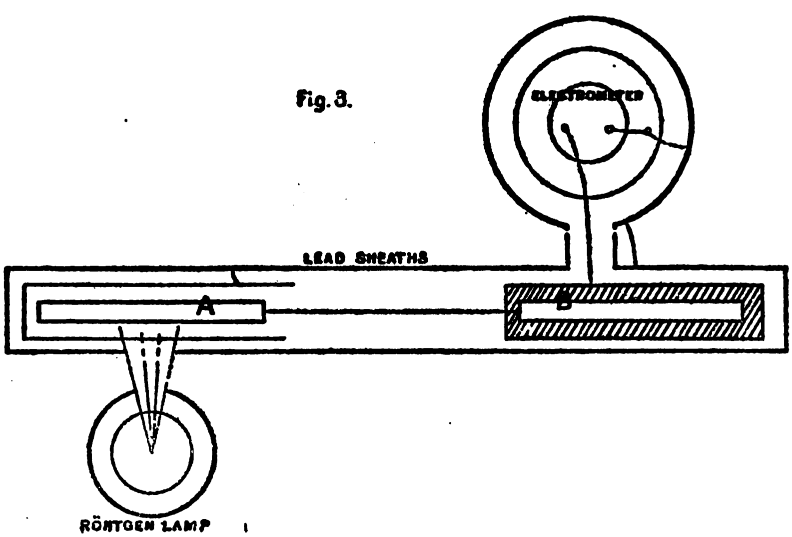
insulated metal was polished zinc, polished aluminium, polished copper, or oxidised copper, both positive and negative charges leaked away at the same rate, if we reckon the charge of the insulated metal from its ultra-violet light-zero, and not from the metallic-zero. By ultra-violet light-zero we mean the steady

reading obtained on the electrometer with the two pairs of quadrants insulated, and the ultra-violet light falling perpendicularly on the insulated metal through the brass wire gauze. This ultra-violet light-zero depends on the nature of the insulated metal and on the distance between it and the brass wire gauze.

In the second method we used an arrangement of two *quasi-*Leyden jars, A and B, with their inside coatings connected together. The outside coating of A was connected to sheaths, the outside of B to the insulated terminal of the electrometer. In all the experiments in which we used this two Leydens' method B remained the same. It consisted of a cylindrical lead can, 25 cms. long, 4 cms. diameter. A metal bar, about .1 cm. diameter, 25 cms. long, was supported centrally on paraffin, filling the whole space between it and the containing lead. This metal bar was connected by a wire to the internal coating of A. To protect this wire from inductive effects, it was surrounded by a tube of lead connected to sheaths.

The Leyden, which was placed opposite the Röntgen lamp, consisted of an aluminium cylinder, 16 cms. long, 3 cms. in diameter. This cylinder projected beyond the lead tube protecting the connecting wire of the internal coatings, and was connected to the case of the electrometer. The insulated metal inside it, which was a flat strip of aluminium, about 10 cms. long and $1\frac{1}{2}$ cms. wide,

Fig. 3.



cut from the same sheet as the surrounding aluminium tube, was supported at one end by a small piece of paraffin, so placed as to be out of reach of the action of the Röntgen rays. These were allowed to pass from the lead cylinder surrounding the lamp by a hole three-quarters of a square inch in area. They fell on the aluminium sheath transparent to them, and rendered the air between it and the insulated aluminium within conductive (see Fig 3).

The differences of potential between the internal and the external coatings of the two Leyden jars were obtained in the following way: —The two pairs of quadrants of the electrometer were first placed in metallic connection. Then one terminal of a battery, or of an electrostatic inductive machine, was connected to the internal coatings of the jars, and the other terminal to the case of the electrometer. The difference of potential produced was measured by a multicellular voltmeter in the case of differences under 500 volts, and on a vertical single vane voltmeter for higher differences.

When the desired difference of potential had been established, the metallic connection of the battery, or the electric machine, with the internal coatings of A and B, was broken, and this changed body left to itself. To find the loss due to imperfect insulation, the pair of quadrants in metallic connection, with the outside coating of B, was insulated in the usual way, and the deviation of the electrometer reading from the metallic-zero was observed per half-minute. To find the loss when the rays were acting the two pairs of quadrants were again placed in metallic connection, and the Röntgen lamp was set agoing; then the pair of quadrants connected to the outside coating of B were insulated from the other pair, and the deviation from the metallic-zero again observed per half-minute.

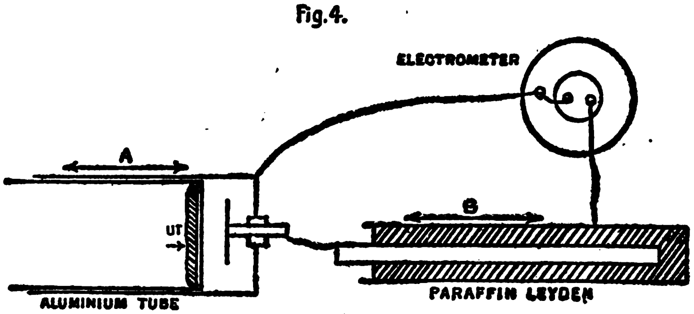
We tried various differences of potential, ranging from a few volts to 2,200 volts. In one series of experiments we charged the insulated metal to $-97{\cdot}5$ volts, and then disconnected the battery electrodes. The lamp was then set agoing, and the electrometer deviation taken each half-minute for a minute and a-half, with one pair of quadrants insulated. The rays were then stopped, the quadrants metallically connected, and metallic-zero again found. Then the reading during another period of one and a-half minutes, with the rays acting, was observed, and so on till no deviation from the metallic-zero of the electrometer was found with one pair of quadrants insulated, and the rays falling on the aluminium outside coating of the Leyden A. The sensibly complete

discharge thus observed took place in about a quarter of an hour. We found that the rate of deviation from the metallic-zero was the same, as the difference of potential fell from $-97\cdot5$ volts to about -4 volts. With differences of potential of -930, -1750, and -2000 volts, the rate of deviation was not appreciably greater than with ± 20 volts.

This confirms and extends, through a very wide range of voltage, the interesting and important discovery announced by J. J. Thomson and M'Clelland.

To measure the leakage in air, at ordinary pressure and at different voltages, due to uranium, we used, in our first series of experiments for this purpose, the two Leydens' method already described. The Leyden A was, in this instance, a cylinder of aluminium, with one end closed with aluminium. This formed the external coating. The internal coating was a disc of aluminium insulated in paraffin. The uranium—the disc of the metal already referred to—was placed inside a cardboard cylinder, with one end open, and the other covered with aluminium, so as to touch

Fig. 4.



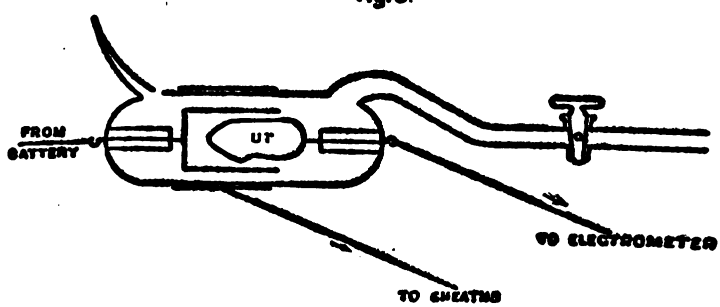
the aluminium. This cardboard cylinder could be moved to and fro in the aluminium cylinder, so that the distance between the insulated disc in the latter and the aluminium end of the former could be varied (see Fig. 4). The uranium influence thus acted through the aluminium end of the cardboard box, and made the air between the end and the insulated aluminium disc conductive. The leakage was, in this way, made slow enough to be easily observed on the electrometer. The rate of leak was not perceptibly increased when the piece of uranium was heated or when the sunlight fell on it.

The aluminium end of the cardboard box and the outside coating of the aluminium cylinder were connected to sheaths. The

insulated aluminium disc was connected to the inner coating of B. The inside coatings were charged to a known potential, and then left to themselves.

We also measured the leakage at different voltages due to a second piece of uranium, 3 cms. long, 1 cm. broad, and ½ cm. thick. This was mounted firmly in a glass bulb, 6 cms. long, 3 cms. diameter, on a platinum electrode fused into the end of the bulb. The uranium in the glass bulb was surrounded throughout two-thirds of its length by a zinc cylinder, one and a-half centimetres in diameter. This zinc cylinder was kept in position by a stiff

Fig. 5.



platinum electrode fused into the other end of the glass (see Fig. 5). Two glass tubes were fixed to the bulb, one at each end. By means of these any desired gas could be introduced, or any desired vacuum could be obtained.

With this bulb filled with dry air at atmospheric pressure, we charged the zinc cylinder to a definite potential, and connected the uranium to the insulated terminal of the electrometer. We found, with both the arrangements already described, that the leakage in air was not proportional to the electromotive force.

With the glass bulb arrangement we also measured the leakage in other gases, both at ordinary pressure and at pressures down to a fraction of a millimetre. We found that the rate of leak is greater in oxygen than in air. The leakage in hydrogen is less than in air. In carbonic acid gas it is less for 4 volts, but greater for 90 volts, than it is in air; for the latter voltage the leak in carbonic acid is greater even than the corresponding leakage for oxygen.

We found that the rate of leak in air at 4 volts and at 96 volts is nearly proportional to the atmospheric pressure. The leakage at pressures lower than 2 or 3 mms. was so small as to be

negligeable. In hydrogen the rate of leak is at higher pressures somewhat approximately proportional to the pressure, at lower ones to the square root of the pressure.

We shall now proceed to give you an account of some experiments by which we measured the difference of potential between wires of the same metal connected with two mutually insulated metals when the air between them was rendered conductive by Röntgen rays, by ultra violet light, or by uranium. It will, perhaps, give you a clearer idea of what we did if we first describe to you a well-known laboratory experiment of the same nature. In this experiment, instead of air—made conductive by different means—slightly acidulated water is used. The two mutually insulated metals are joined to the two pairs of quadrants of an electrometer, and are brought within such a distance of one another as to render it possible to put them in electric connection by a drop of water. If the quadrants of the electrometer are then insulated, the reading deviates from the metallic-zero till a definite difference of potential is indicated. This is the potential difference due to the electrically effective surfaces of the metal when put into electric connection by a drop of acidulated water. Instead of a drop of water being used as the electric connector, we could use a piece of wet blotting paper. The reading obtained with it would, in general, be different from that obtained when water was used. What we have done is to use air made conductive by Röntgen rays, by ultra-violet light, or by uranium, as the electric connector.

The first to use air in this way was Righi. He determined the difference of potential of wires of the same metal connected to two insulated conductors by rendering the air between the insulated conductors conductive by means of ultra-violet light. Minchin, Righi, and Murray have made experiments of a similar kind with Röntgen rays.

We found that the difference of potential with air made conductive in any one of these three ways depended in all of them very much on the state of polish of the insulated metals. With the air made conductive by Röntgen rays or by uranium, the difference of potential observed did not depend on the distance between the two insulated metals; when ultra-violet light was used, it did depend on distance.

THE MECHANICAL PROPULSION OF TRAMWAY CARS.

XVI.—*A Discussion of the relative merits and prospects of the following systems:—Steam Engines, Compressed-Air Engines, Gas Engines, Oil Engines, Underground Cable, and Electric Motors.* By Professor W. H. WATKINSON, Glasgow and West of Scotland Technical College.

[Abstract of Paper communicated to the Society, 18th November, 1896.]

UNTIL quite recently there has been no pronounced demand in this country for rapid street transit, and on this account comparatively few British engineers have devoted their attention to this department of engineering, which, owing to recent legislation in connection with ordinary road carriages, promises to become in the near future one of our greatest industries. The demand for rapid street transit has now become so pronounced, the benefits to be derived from it are now recognised to be so great, and the loss to a city like Glasgow through the lack of it is seen to be so enormous, that the public will not long tolerate the present slow and cruel system of horse traction.

In the admirable and most valuable series of articles on this subject which have recently been contributed to the *Glasgow Herald* by the special commissioner which that enterprising paper sent to the United States of America for the purpose, the financial part of the subject has been very fully reported upon and discussed, so to-night I purpose dealing with the subject almost solely from the engineering point of view.

The different methods of mechanical traction which at present seem most promising are steam, compressed-air, gas, and oil engines, the underground cable, and electric motors—the great merit of the first four being that each car is independent, and, therefore, a general breakdown of the system is impossible. The

other two systems — the underground cable, and the electric, (without storage batteries)—depend for their success mainly on the fact that with them the prime movers at the central stations can be very large and of the most economical types. This is almost their only claim for supremacy. Steam traction is still considered by some of the most eminent engineers to be the most suitable at present, both for the propulsion of tramway cars and ordinary street carriages. Unfortunately, until recently, the problems involved in the design and construction of light boilers and engines have not been clearly realised, but, thanks to the work of Thornycroft, Yarrow, Serpollet, and others, we now know how to construct steam motors which, for efficiency and lightness, surpass all others. It is no longer necessary to provide a separate locomotive, as the whole of the apparatus can be placed on the passenger car itself, thus reducing enormously the total weight to be propelled. The great advantages of the steam engine are due to the ease with which it may be started, and its direction of motion reversed; and to its being able to exert great power with small loss of efficiency during the starting of a car and on inclines, and to work with maximum efficiency under the normal load.

The principal drawbacks to the steam engine, when fitted with an ordinary boiler, are the smell and dirt from the products of combustion; but by the use of coke or oil as fuel, and by letting the chimney discharge downwards on to the road beneath the car, these difficulties are practically got rid of. In connection with tramway cars these difficulties may be completely overcome by dispensing with the furnace altogether, the steam being generated from superheated water, carried in suitable reservoirs beneath the car, these being replenished at a central boiler station.

The difficulties connected with the design of motors for tramway cars will be better realised by considering briefly the forces and power involved. On a good, clean, level tramway line the force required to move the car varies from 15 lbs. to 30 lbs. per ton. Taking it at 25 lbs. per ton (an average value) on the level, it will have the following values on inclines:—

On incline of 1°/。 the force required per ton $= 25 + 22 \cdot 4 = 47 \cdot 4$ lbs.
" 2°/。 " " " $= 25 + 44 \cdot 8 = 69 \cdot 8$ lbs.
" 5°/。 " " " $= 25 + 112 = 137$ lbs.

In some parts of Renfield Street the incline is 5°/$_o$, and as, from the above, the force required on a 5°/$_o$ incline is 5·5 times ($\frac{137}{25}$) the force required on the level, we can partially realise the terrible strain to which the horses are subjected.

The force necessary to start a car from rest is usually about four times as great as the force required to keep it in motion; therefore, to start a car on a 5°/$_o$ incline requires about 22 times the force which is required to keep it moving on the level.

Taking the resistance to traction at 25 lbs. per ton, the power required at 8 miles per hour is as follows:—

Power required on level, -	= ·53 horse-power	per ton.	
,, incline of 1°/$_o$	= 1·0	,,	,,
,, ,, 2°/$_o$	= 1·48	,,	,,
,, ,, 5°/$_o$	= 2·9	,,	,,

These results do not include the power lost in the motor, or by slipping of the car wheels on the rails.

The weight of horse cars and of cable cars for 40 passengers is about $2\frac{1}{4}$ tons, and the weight of electric cars on the overhead trolley system for the same number of passengers is from 5 to 6 tons. The average weight of each passenger may be taken at 120 lbs., and the average number of passengers in the Glasgow cars is about eleven.

The car-load efficiency may be taken as =
Average weight of passengers, divided by
Total weight of car and passengers (including driver and conductor).

For a cable car, with eleven passengers, the load efficiency is—

$$= \frac{11 \times 120}{2\frac{1}{4} \times 2240 + 13 \times 120} = \cdot 2$$

For an electric car with the overhead trolley system the load efficiency is—

$$= \frac{11 \times 120}{5 \times 2240 + 13 \times 120} = \cdot 103$$

Steam Cars.

The main difficulty with steam cars in the past has been the great weight and bulk of the boiler, but the recent developments in the construction of water-tube boilers have reduced this difficulty almost to the vanishing point.

In Figs. 1 and 2 (Plate III.) are shown views of the Thornycroft steam van. In Fig. 1 B is the boiler, E the compound steam

engine, and C is the condenser. The total weight of the 11-feet van shown is only 30 cwt., including engine, boiler, condenser, &c. Fig. 3 gives a general view of the boiler.

Two views of a Serpollet steam tramway car are shown by Figs. 4 and 5. The main feature of the Serpollet system is the boiler, details of which are shown in Figs. 6, 7, and 8. From Fig. 6, which is a transverse section of one of the tubes, it will be seen that the boiler is of the forced circulation "flash" type; there is no steam or water drum, and the total amount of water in the boiler, when in action, is only a few ounces, and on this account the boiler is an absolutely safe one. The tubes are heated externally by a coke or oil fire; water is pumped in at one end of the coil, and highly superheated steam is delivered from the other end to the engine. On account of the steam being highly superheated, the consumption of steam per hour per horse-power is only about 25·5 lbs. A condenser is not generally used in connection with this sytem; but as the exhaust steam is superheated, it is quite invisible. A condenser is, however, being applied in the most recent examples. A number of cars with this generator are now being used in Paris. The fire is only stoked at each terminus, the car running six miles without any attention to the fire being necessary. The consumption of coke per car mile for a car carrying 100 passengers is only 6 lbs., so that, with coke at 16s. per ton, the cost for fuel is only about a halfpenny per car mile.

COMPRESSED-AIR MOTORS.

Compressed air has long been used for the transmission of power, but, until recently, it has been generally believed that this system was necessarily inefficient. In the most modern systems of distribution of power by compressed air, triple-series cylinder compressors are used, having a mechanical efficiency of 85 per cent., and compressing the air to a pressure of 2,000 pounds per square inch. In this way the efficiency at the central station has been very greatly increased as compared with the older plants. The efficiency of the motors has also been very greatly increased by heating the air, either previous to or during expansion, in the motor cylinders. In connection with tramway cars the air is compressed at convenient central stations, and the air reservoirs beneath the cars are recharged periodically at these stations. The motors generally used are very similar to steam engines. The air is heated before entering the cylinders of the

engines, either by being passed through hot water, or by means of a petroleum lamp. At Berne, where the Mekarski system has been in use since 1890, the air-pressure is only 450 lbs. per square inch. The capacity of the reservoirs is 75 cubic feet on each car, and the capacity of the hot-water tank is 3½ cubic feet. The air passing through this water is heated prior to being sent to the engine.

Compressed air is now being tried in New York, and it is said that the results are most satisfactory. The main difficulty in connection with compressed-air traction is the great weight of the reservoirs for storing the air on the cars. This difficulty can be reduced, either by recharging the reservoirs automatically at very frequent intervals, as on the Hughes-Lancaster and Popp-Conti systems, or by making the engines either gas or oil engines, for these are, of course, compressed-air engines, which, however, usually act as their own compressors. So far as the motor is concerned, the compressed-air engine has the same advantages as the steam engine, and, being without a boiler, it is somewhat cleaner. The weight of the reservoirs, however, of the compressed-air system is very much greater than the weight of the steam boiler.

Gas and Oil Engines.

Two other types of compressed-air motors—namely, gas and oil engines—at present seem to promise to become *the* most successful of all motors for tram cars and motor carriages generally. But at present, owing to the universal use of the "Otto" cycle, they are not mechanically as perfect as the systems to which I have already referred.

All the gas engines at present in use on tram cars have the great drawback that their direction of motion cannot be reversed, and, therefore, gearing has to be used for this purpose. In spite of this, gas-engine tramway cars are now working successfully, and at a lower cost than cars worked by any other system.

At Dresden, where the Lührig system of gas-engine propelled cars has been in use for some time, the total cost of operating them is given as 3·74 pence per car mile, while the electric cars at the same place cost 4·44 pence per car mile. At Blackpool, where this system is also used, the consumption of gas is only 38 cubic feet per 40-passenger car mile, including the gas used for driving the compressor at the station. On these cars a two-cylinder "Otto" cycle engine is used of 14 brake horse-power.

The engine drives the car axles through toothed wheels and chain gearing, friction clutches being used for throwing the axles in and out of gear, and for reversing. Electric ignition is used, and great care has been taken in working out the details. The cars run very smoothly and successfully, and the vibration is very slight, while the smell due to the products of combustion is scarcely noticeable. This system seems at present to be very well adapted for comparatively level lines, but, until some other cycle is adopted, it does not seem likely to be suitable for hilly routes. Figs. 9 and 10 show two views of tramway cars on this system.

OIL MOTORS.

All the oil motors at present on the market work with the "Otto" cycle, and they, therefore, share the drawbacks of the gas-driven tramway cars. They are at present less reliable in action than gas engines, and, unless heavy oil is used by them, they are less safe than any of the systems already mentioned. The oil motor is, however, by far the most promising type of motor for this class of work, but the difficulties to be overcome before it can compete successfully with the steam engime in connection with the propulsion of tramway cars are enormous. Thermo-dynamically they are at present far more efficient than the steam engine, but, as they use a much dearer fuel, they are more costly in operation. For light motor carriages, and possibly for light tramway cars on level lines, they are at present sufficiently developed for successful application, but no public trials have, so far as I am aware, been made of any oil motor which is suitable for general tramway traction. Figs. 11 and 12 show two views of a small tramway car driven by a Daimler oil engine.

CABLE TRACTION.

This system is undoubtedly at present the most efficient system of tramway traction for heavy city work, especially in hilly districts. Its main drawbacks are its great first cost, and the fact that a breakdown of the cable affects the whole of the cars worked by that cable. Another difficulty is in connection with the extension of the system when once laid down. The latter difficulty might be got rid of by driving the cable for the extended portion of the line by means of an electric motor. The initial cost of the conduit, as well as the depth of the conduit, are considerably reduced by the adoption of the Wilson-Sturgeon system, illustrated by Figs. 13, 14, and 15.

With the improved cables now used the cost of renewals has been greatly reduced. On the Brixton line, for example, with a one-minute service, the cost of renewal of the cable is only ·16 penny per car mile, or $\frac{1}{836}$ penny per passenger. According to D. K. Clark, the engine-power required at the central station is equal to 4 horse-power per 1,000 feet cable + 1,500 feet for each right angle curve + 3 horse-power for each car of ordinary size + 60 horse-power for engines and machinery. Using this equation, the author has plotted the power and efficiency curves for cable traction, the results being shown in Fig. 16. With cable traction the wear and tear of the tramway lines and the streets are less than with any other system. The wear of the rails is obviously a minimum, because there is no slipping and grinding between the wheels and the rails, as with every other form of mechanical traction. The weight of the rails may also be less than with any other mechanical system, as the weight of a car is also a minimum. With electric cars the wear of the rails is greater than with any other system, because of the sparking which takes place between the wheels and the rails. This, combined with the grinding action between the wheels and the rails incidental to all motor cars, causes rapid deterioration both of rails and wheel tyres.

Electrical Traction.

The ideal system of electrical traction is by means of secondary batteries, but, unfortunately up to the present, the deterioration of these has been very rapid when used for tramway-car work. Their efficiency is low, and their weight is excessive. On account of these drawbacks, this system is now rarely used. The system of electrical traction which has proved most successful in practice is what is known as the overhead trolley system. With this system two or more electro-motors are fixed beneath each car, and their motion is transmitted to the car axles by means of worm or spur gearing. The electric current is generated at a central station, and is distributed through the streets by means of naked copper conductors, supported by poles or transverse wires. The pressure adopted is usually about 500 volts. The current is collected from the overhead wires by means of a bronze trolley pulley or its equivalent. It is then conducted to the motors, and on leaving these it passes through the wheels of the car to the rails, and flows back to the central station, either through the rails or through the rails and special return wires.

The different sections of the rails are metallically connected together either by copper strips and pins or bolts, or the rails are all electrically welded into one long rail. Unless the rails are thoroughly connected, the current leaks to earth, and causes rapid corrosion of the gas and water pipes. When the rails are thoroughly bonded the corrosion of these pipes is very slight. Fig. 17 shows a tramway motor rated at 25 horse-power; its weight, with gearing, is 1,500 lbs. Fig. 18 illustrates the method adopted in Hamburg and Dresden. Besides the overhead trolley system, there are a great many different types of open and closed conduit electric systems, but up to the present the great initial cost of these has prevented their extensive adoption.

EFFICIENCY OF ELECTRICAL TRACTION.

The engines and dynamos at electric-power stations are usually very efficient, but the combined efficiency of the whole plant in connection with an electrical tramway is necessarily low. Professor Kennedy, in his presidential address to the Institution of Mechanical Engineers in 1894, summarised the different efficiencies as follows:—

	Per cent.
Mechanical efficiency of engine,	85
Efficiency of belt-driving (if employed),	94
Efficiency of dynamo,	90
Efficiency of line,	85
Efficiency of motors,	85
Efficiency of gearing,	75
Total efficiency,	39

This summary shows clearly where the different losses occur, but, in considering the relative efficiencies of the cable and of the electrical systems of traction, it is important to remember that the electrical car weighs more than twice as much as the cable car of the same carrying capacity. In Fig. 16 the power curve and two efficiency curves for electric traction are given. These curves being for the case of empty cars, the upper efficiency curve is the one usually given, but obviously the lower one more accurately represents the useful efficiency.

The main advantages of the electrical overhead system are its great flexibility and its comparatively low first cost.

Conclusions.—As in Glasgow it is absolutely necessary either to spend a large sum for increased stable accommodation, &c., or

to go in at once for mechanical propulsion; and as the electrical method has already proved financially successful in other places, besides providing a much more rapid means of transit, it is probably wisest to give this system a trial on one or more sections, although it is almost certain that the present overhead system and the present type of motors will be obsolete and will have to be replaced in a few years. In the meantime it would also be well to try other systems, such as the Serpollet steam and Lührig gas systems. Both these systems could be tried for about a tenth of the cost which would be involved in the equipment of the Mitchell Street and Springburn section with the overhead electric system.

PLATE III. VOL. XXVIII.

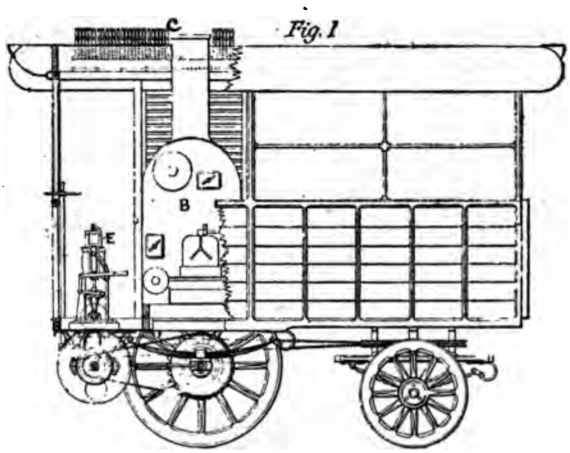
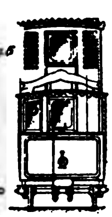


Fig. 2.

Fig. 3.



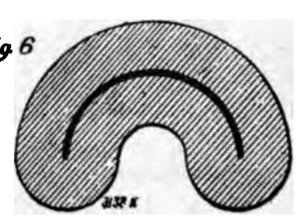


Fig. 7

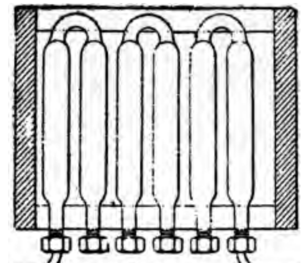
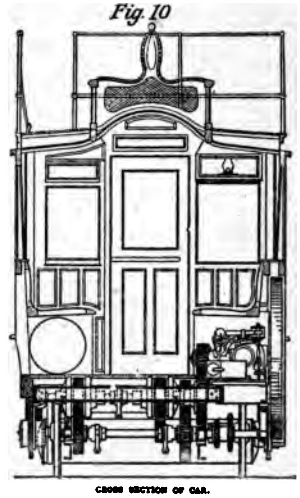


Fig. 8

Fig. 9.

Fig. 10

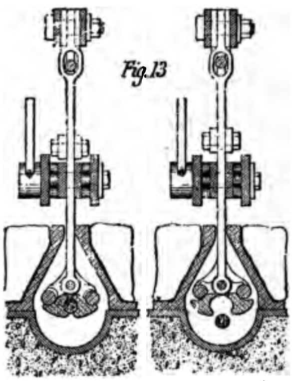


CROSS SECTION OF CAR.

Fig. 11.

Fig. 12.

Fig.13



Showing gripper closed.

Showing gripper open and cable dropped.

Fig. 14

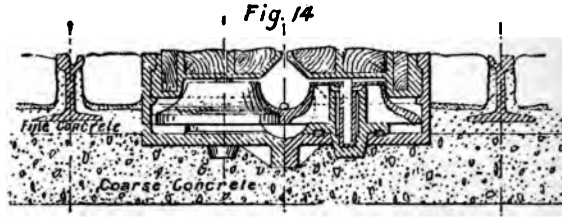
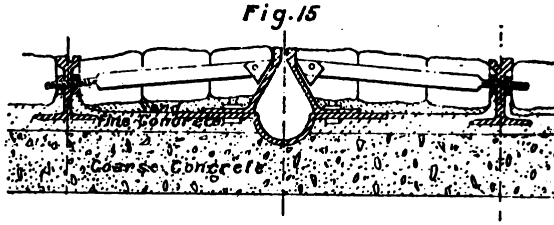


Fig. 15



POWER AND EFFICIENCY CURVES
FOR CABLE AND ELECTRIC TRAMWAYS.

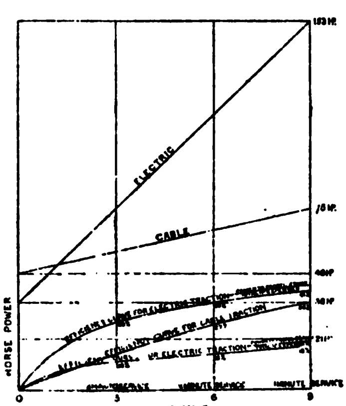


Fig.16

Fig. 17.

Fig. 18.

MINUTES OF SESSION,

1896-97.

4th November, 1896.

The Philosophical Society of Glasgow held its First Meeting for Session 1896-97, in the Society's Rooms, 207 Bath Street, on the Evening of Wednesday, 4th November, 1896, at Eight o'clock—Dr. Eben. Duncan, President, in the Chair.

1. The Minutes of Meeting held on 29th April, 1896, were read and approved of, and signed by the Chairman.

2. On behalf of the Council, Dr. Freeland Fergus, as Sub-Convener of the Kelvin Bust Committee, made a statement regarding the arrangements for holding the Jubilee of Lord Kelvin's admission into the Philosophical Society, the fiftieth anniversary of which would occur on 2nd December, 1896. He said it was proposed to give up the whole of that evening to the Jubilee proceedings, one part of which would be the presentation of an address to the noble lord. It was also proposed to nominate his Lordship for election as an Honorary Member of the Society, and to admit him with that status on 2nd December, when he would sign the Membership Roll afresh. On the motion of Dr. Fergus, seconded by Mr. Barrett, the meeting approved of the action of the Council.

3. The President then proceeded to deliver the Opening Address, the subject of which was "The Scottish Races: their Ethnology, Growth, and Distribution," illustrated by Diagrams, Specimens of Ancient Bones, &c. On the motion of Dr. George A. Turner, the President was awarded a hearty vote of thanks for his address.

4. Mr. John Donald and Mr. George C. Thomson were appointed Auditors to examine the Hon. Treasurer's Accounts for the year 1895-96.

5. The Chairman announced that all the new Candidates for admission into the Society, as follow, had been elected:—

1. Mr. Oswald Fergus, Dental Surgeon, 27 Blythswood Square. Recommended by Prof. Joseph Coats, M.D., Mr. F. T. Barrett, and Mr. John Mann.
2. Mr. J. W. O. Walker, Manager, Glasgow Rubber Works, Huntly Terrace, Kelvinside. Recommended by Mr. John F. Campbell, Mr. J. M'Kellar, and Mr. Wm. Henry Houstoun.
3. Mr. R. U. Strachan, Sheriff-Substitute, 9 Crown Circus. Recommended by Mr. Wm. Borland, Mr. John A. Spens, and Dr. David Murray.
4. Mr. John R. K. Law, Iron Merchant, 20 Ashton Gardens, Dowanhill. Recommended by Mr. Grahame H. Thomson, Mr. H. L. Seligmann, and Mr. Thomas S. Cree.
5. Mr. G. F. Scott Elliot, M.A., B.Sc., F.L.S., F.R.G.S., 12 Wilton Mansions, Hillhead. Recommended by Prof. A. Humboldt Sexton, Mr. George R. Thompson, and Dr. G. G. Henderson.

18th November, 1896.

The Annual Meeting of the Philosophical Society of Glasgow was held in the Society's Rooms, 207 Bath Street, on the Evening of Wednesday, 18th November, 1896, at Eight o'clock—Dr. Eben. Duncan, President, in the Chair.

1. The Minutes of Meeting held on 4th November, 1896, which were printed in the Billet calling the Meeting, were read and approved of, and signed by the Chairman.

2. The following new Members, who were elected at the Opening Meeting of the Session, were formally admitted:—

1. Mr. Oswald Fergus, Dental Surgeon, 27 Blythswood Square.
2. Mr. J. W. O. Walker, Manager, Glasgow Rubber Works, Huntly Terrace, Kelvinside.
3. Mr. R. U. Strachan, Sheriff-Substitute, 9 Crown Circus.
4. Mr. John R. K. Law, Iron Merchant, 20 Ashton Gardens, Dowanhill.
5. Mr. G. F. Scott Elliot, M.A., B.Sc., F.L.S., F.R.G.S., 12 Wilton Mansions, Hillhead.

3. Several new Candidates for election as Members were announced.

4. The President moved the adoption of the Council Report for Session 1895-96, which was printed in the Billet. It was unanimously approved of. The Report was as follows:—

REPORT OF COUNCIL FOR SESSION 1895-96.

I. *Meetings.*—Thirteen meetings of the Philosophical Society of Glasgow were held last Session. The opening meeting took place on Wednesday, 6th November, 1895, when Professor Ferguson, LL.D., President, delivered his retiring address, the subject being "A Review of the Labours of the late Dr. Hermann Kopp, of Heidelberg, as a Historian of the Science of Chemistry." Including that address, and two special lectures, both of which were illustrated, twenty-one communications were made to the Society during the Session.

II. *Special Lectures.*—The "Graham" Lecture was delivered on the 8th January, 1896, by Dr. William Ramsay, F.R.S., Professor of Chemistry in University College, London, a former Member of the Philosophical Society. The subject of the lecture was "Argon and Helium." On the 19th February, 1896, another special lecture was delivered before the Society, being the first under the Glasgow Science Lectures Association Trust. It was a joint-lecture on "The Ben Nevis Observatories and their Work," by Dr. Alexander Buchan, M.A., F.R.S.E., Secretary of the Scottish Meteorological Society, and Mr. R. T. Omond, F.R.S.E., Superintendent of the Observatories. These lectures were well attended, many non-members being admitted by tickets, for which a charge was made. The Council contemplate making the Science Lectures Association Trust Lecture an annual event. The lecture for this Session will be delivered (probably on 16th December, 1896) by Professor M'Kendrick, F.R.S., Past-President of the Society, his subject being—"Wave Motion as revealed by the Phonograph."

III. *Visit of Members to Glengarnock.*—Near the close of last session arrangements were made for a number of members visiting the Glengarnock Iron, Steel, and Ammonia-recovery Works. Professor Sexton took charge of the party, and gave interesting explanations of the various processes witnessed and plant inspected. Other such visits are contemplated for the current Session of the Society.

IV. *Sections.*—Eight meetings were held by the *Architectural Section* during the Session. The opening address of the President, Mr. T. L. Watson, I.A., F.R.I.B.A., the subject of which was "Glasgow Cathedral: a Contribution to the History of the Structure," appears in the new volume of the Society's *Proceedings.* Two communications in connection with the *Geographical and Ethnological Section* were given at one of the meetings of the Society. Three papers from the *Economic Science Section* were read before the Society, and have all been printed in the *Proceedings.* The *Mathematical and Physical Section* provided three communications on the "New Photography" by Lord Blythswood, Dr. J. T. Bottomley, and Dr. John Macintyre. Two papers were read before the Society from the *Sanitary and Social Economy Section*, and the *Philological Section* provided one paper.

V. *Proceedings, Volume XXVII.*—This volume of the *Proceedings*, which will shortly be distributed to the members, contains eighteen separate communications—two of them in abstract. Several of the communications are of such a character as to give a special value to the volume.

VI. *Obituary.*—Death has overtaken at least three prominent members of the Society since last Annual Meeting, namely—Mr. W. P. Buchan, Sanitary Engineer; Mr. Robert Blackie, member of an old-established and eminent printing and publishing firm in Glasgow; and Mr. George Anderson, ex-M.P. for the city. Messrs. Buchan and Blackie took part in the proceedings of last Session. A biographical notice of Mr. Buchan is given in the new volume of the Society's *Proceedings*. Of Mr. Blackie it may be said that he joined the Society so far back as 1847, but six years after his brother, Dr. W. G. Blackie, who has long been the oldest member of the Society. Mr. Blackie served as a member of Council many years ago, but he never read any papers before the Society. Mr. Anderson became a member of the Society in 1856, and shortly afterwards he served in the Council for a term of three years. On retiring from Parliament in the year 1885 to become Master of the Mint at Melbourne, Mr. Anderson was elected a Corresponding Member of the Society, in whose welfare he took a lively interest till his death, which occurred on 5th November of this year. In 1857 and 1863 he contributed two valuable papers to the Society's *Proceedings*.

VII. *Lord Kelvin's Jubilee as a Member of the Society.*—In the early part of this year, when attention was drawn to the fact that Lord Kelvin had been on the Society's Membership Roll for the long period of fifty years, the Council resolved that it was desirable to recognise this interesting fact. They accordingly appointed a Committee of their number to raise a subscription fund amongst the members of the Society to provide a portrait bust of his Lordship to be placed in the Society's rooms, with a replica to be presented to Lady Kelvin. The request for subscriptions was liberally responded to. The bust has been modelled by Mr. A. M'Farlane Shannan, a Glasgow artist, and has since been reproduced in bronze in London. Arrangements have been made for the presentation and jubilee ceremony to take place at the Society's Ordinary Meeting on the evening of Wednesday, 2nd December, exactly fifty years from the date of Lord Kelvin's admission to the Society.

VIII. *Invitation to the British Association.*—Through the action taken by the Council in the course of the past summer in favour of an invitation being given to the British Association to hold an early meeting in Glasgow, the Municipal Authorities resolved on making formal application for a visit of the Association in 1898, and sent a deputation to the meeting recently held in Liverpool to present the invitation. The deputation was headed by Sir James Bell, Bart., Lord Provost, and was joined by the President and other members of the Philosophical Society. On communication with the permanent Officers of the Association in Liverpool, it was found that Bristol had already made initiatory arrangements for a meeting in that year, and accordingly the Lord Provost, on behalf of the deputation, refrained from presenting the invitation.

IX. *Membership.*—At the beginning of the Session there were 620 Ordinary Members on the Roll. In course of the Session 22 candidates were elected, and 1 Member was reinstated, making 643. Of these, 13 have resigned, and 10 have died, 4 have left Glasgow, and their names have been placed on the "Suspense List," and 11 have been struck off the Roll for non-payment of subscriptions, so that at the beginning of 1896-97 there were 605 Members, being a decrease of 15. Of the new Members admitted during the Session, 3 qualified themselves as Life Members. There are now 142 Members of that class out of the 155 who had so enrolled themselves. In the list of Honorary Members, the number of whom is limited to 20, there are 5 vacancies, and the Roll now includes 15 Honorary Members, 3 being Continental, 4 American or Colonial, and 8 British. The number of Corresponding Members is 8. The Membership of the Society, then, is as follows:—Honorary Members, 15; Corresponding Members, 8; Ordinary Members (Annual and Life), 605; or a total of 628.

X. *Finance.*—The Treasurer's Statement opens with an available balance of £28 1s. 5½d., to which add the Investment mentioned in former Reports, £294 18s. 3d., making £322 19s. 8½d. The Accounts close with a balance of £25 in Bank, add £5 5s. 4d. in hands of Treasurer, making, with the above investment, £325 3s. 7d., so that there has been an increase during the year of £2 3s. 10½d. All current indebtedness to the closing date of financial year is believed to have been paid, except a bookbinding account not rendered.

Separate Statements are given by the Treasurer showing the position of the two funds which the Society holds in trust, viz.:—"The Graham Medal and Lecture Fund," and "The Glasgow Science Lecture Fund," respectively.

By Order and in name of the Council,

(Signed) JOHN MAYER,
Secretary.

5. On the motion of Mr. Gilbert Thomson, the Treasurer's Financial Statements, which had been duly audited, were also approved of (see pages 306 and 307).

6. The adoption of the Annual Report of the Library Committee on the State of the Library was moved by Mr. F. T. Barrett, and both he and Mr. Robertson, Librarian, expressed regret that the Members did not make more extensive use of the very valuable collection of books belonging to the Society. The Report, which was as follows, was adopted:—

Report of the Library Committee.

Your Committee have to report that during the past session the number of members who read from the Library was scarcely so great as during the previous year, 610 volumes having been issued to 456 members.

Dr. ABSTRACT OF HONORARY TREASURER'S

AND COMPARISON WITH

			1895-96.	*1894-95.*
To BALANCE from last year—				
In Bank, less due Treasurer,		£28 1 5½		
Investment, Caledonian Railway,		294 18 3		
			£322 19 8½	*£297 15 9¼*
,, SUBSCRIPTIONS to 31st October, 1896—				
23 Entry-moneys of 1895-96 at 21s.,		£24 3 0		
Annual Dues at 21s.—				
Arrears,	£5 5 0			
For 1895-96, 443 Ordinary Members,	465 3 0			
,, ,, 20 New Members,	21 0 0			
		491 8 0		
Life Subscriptions at £10 10s.—				
3 Old Members,	£31 10 0			
3 New Members,	31 10 0			
		63 0 0		
			578 11 0	*597 9 0*
,, DIVIDENDS ON INVESTMENT—				
Caledonian Railway, April, 1896, less tax,		£5 4 5		
,, ,, Oct., ,, ,,		5 4 5		
Premium on Allotment Letter,		0 11 2		
			11 0 0	*10 8 10*
,, GENERAL RECEIPTS—				
Bank Interest,		£1 16 4		
Proceedings sold,		0 7 10		
			2 4 2	*3 19 3*
,, LEGACY by the late Sir Michael Connal—Third instalment, less duty,			2 5 0	*1 2 6*
,, ARCHITECTURAL SECTION—				
Associates' fees for 1895-96 at 5s.,			20 0 0	*21 10 0*
,, ECONOMIC SCIENCE SECTION—				
3 Associates' fees for 1894-95, at 5s.,		£0 15 0		
14 ,, ,, 1895-96, at 5s.,		3 10 0		
			4 5 0	*4 0 0*
,, GEOGRAPHICAL AND ETHNOLOGICAL SECTION—				
Associates' fees,			6 15 0	*4 0 0*
			£947 19 10½	*£940 5 4½*

Memo. by Treasurer.—The Society's Investments are—(1) Bath Street Joint Buildings, as in last Account, ... £3,547 8 1½
whereof, Paid from Society's Funds, ... £2,047 8 1½
Do. Society's half of £3,000 Bond, . 1,500 0 0
(2) Caledonian Railway Stock, as in foregoing Account, . . 294 18 3

£3,842 6 4½

J.M.

ACCOUNT—SESSION 1895-96. **Cr.**

SESSION 1894-95.

		1895-96.	*1894-95.*
By GENERAL EXPENDITURE to 31st October, 1896—			
Salary to Secretary, - - - - - -	£75 0 0		
Allowance for Treasurer's Clerks, - -	15 0 0		
Commission to Collector, - - - - -	5 15 6	£95 15 6	*£90 0 0*
New Books & Periodicals, British & Foreign,	£136 0 8		
Bookbinding, - - - - - - - -	0 6 6		
Printing Circulars, *Proceedings*, &c., -	121 0 0		
Lithographs, &c., for *Proceedings*, &c,, -	10 9 8		
Postage and delivery of Circulars, Letters, &c.,	32 6 1		
Stationery, &c., - - - - - - -	2 5 6	302 8 5	*334 16 8*
Fire Insurance on Library for £5,400, -	£6 3 6		
Postages, &c., per Secretary, £2; per Treasurer, £2 10s. 10½d., & Sundries, £1 8s. 4d.,	5 19 2½	12 2 8½	*11 6 3½*
,, Joint Expenses of Rooms—Society's half of (1st) £412 12s., being Interest on Bond, Insurance, Taxes, Cleaning, Repairs, Lighting, and Heating; Salaries of Curator and Assistant; (2nd) of Electric Light Fittings, £63 5s. 6d., less half of £94 5s., Revenue from Letting, - - - - - - - - - -		190 16 3	*157 11 2½*
,, LECTURE EXPENSES— Lanternist, - - - - - - - - - -		1 5 0	*6 0 10*
,, SUBSCRIPTIONS TO SOCIETIES—			
Ray Society, 1895, - - - - - -	£1 1 0		
Palæontographical Society, 1895, - -	1 1 0	2 2 0	*2 2 0*
,, SANITARY AND SOCIAL ECONOMY SECTION— Expenses per Treasurer of Section, - - - - -		0 2 6	*0 0 0*
,, ARCHITECTURAL SECTION— Expenses per Treasurer of Section, - - - - -		16 11 9	*10 17 7*
,, ECONOMIC SCIENCE SECTION— Expenses per Treasurer of Section, - - - - -		1 2 8	*0 5 ·8*
,, GEOGRAPHICAL AND ETHNOLOGICAL SECTION— Expenses per Treasurer of Section, - - - - -		0 9 6	*4 5 5*
,, BALANCES, viz. :—			
Investment—Caledonian Railway £360 3 per cent. Preferred Converted, -	£294 18 3		
In Clydesdale Bank, - - - - -	25 0 0		
In Treasurer's hands, - - - - -	5 5 4	325 3 7	*322 19 8½*
		£947 19 10½	*£940 5 4½*

GLASGOW, *10th November, 1896.*—We, the Auditors appointed by the Society to examine the Treasurer's Accounts for the year 1895-96, have examined the same, of which the above is an Abstract, and have found them correct, the Balance in Bank being Twenty-five Pounds, and in Treasurer's hands Five Pounds Five Shillings and Fourpence.

(Signed) JOHN DONALD.

JNO. MANN, C.A., *Honorary Treasurer.* GEO. CARRUTHERS THOMSON.

GRAHAM MEDAL AND LECTURE FUND.

ABSTRACT OF TREASURER'S ACCOUNT—SESSION 1895-96.

Dr.

CAPITAL AT 1ST NOVEMBER, 1895—		
Glasgow and South-Western Railway Co. 4 °/o Preference Stock in name of the Philosophical Society, in Trust,	£250 0 0	
Value of Die at H.M. Mint,	18 18 0	
		£268 18 0
Cash in Bank,		54 5 9
REVENUE—		
Dividend, April, 1896, less Tax,	£4 16 8	
„ Oct., „ „	4 16 8	
Interest from Bank,	0 8 9	
		10 2 1
TICKETS sold for Professor Wm. Ramsay's Lecture,		5 2 0
		£338 7 10

Cr.

CAPITAL AT 31ST OCTOBER, 1896—		
Investment, *per contra*,	£250 0 0	
Die,	18 18 0	
		£268 18 0
EXPENDITURE—		
Honorarium and Expenses for Professor Wm. Ramsay's Lecture on 8th January, 1896, on "Argon and Helium,"		25 11 0
BALANCE, BEING REVENUE—		
In Bank, on Deposit Receipt,		43 18 10
		£338 7 10

GLASGOW, 10th November, 1896.—Examined and found correct.

(Signed) JOHN DONALD.
GEO. CARRUTHERS THOMSON.

JNO. MANN, C.A., *Honorary Treasurer.*

THE SCIENCE LECTURES ASSOCIATION FUND.

Dr. ABSTRACT OF TREASURER'S ACCOUNT—SESSION 1895-96. Cr.

Dr.

CAPITAL AT 1ST NOVEMBER, 1895—		
£200 Caledonian Railway Company 4% Preference Stock, No. 1, in name of the Philosophical Society, in Trust, cost,	£244 4 8	
On Deposit Receipt,	8 5 4	
		£252 10 0
Cash in Bank (Revenue),		49 16 4
REVENUE—		
Dividend, April, 1896, less Tax,	£3 17 4	
,, Oct., ,, ,,	3 17 4	
Interest from Bank,	0 9 8	
		8 4 4
TICKETS sold for "Ben Nevis" Lecture,		2 7 0
		£312 17 8

Cr.

CAPITAL AT 31ST OCTOBER, 1896—		
Investment, *per contra*,	£244 4 8	
In Bank, on Deposit Receipt,	8 5 4	
		£252 10 0
EXPENDITURE—		
Honorarium and Expenses for Lecture on 19th February, 1896, on "The Ben Nevis Observatories and their Work," by Dr. Alex. Buchan and Mr. R. T. Omond,		17 14 3
BALANCE, BEING REVENUE—		
In Bank, on Deposit Receipt,		42 13 5
		£312 17 8

GLASGOW, 10th November, 1896.—Examined and found correct.

(Signed) JOHN DONALD.
GEO. CARRUTHERS THOMSON.

JNO. MANN, C.A., *Honorary Treasurer.*

The Committee, since last annual meeting, have added to the Library, by purchase, largely on the recommendation of Members, 67 volumes and 13 parts of works, while 17 volumes, 7 parts, and 7 pamphlets were presented.

The Society at present receives 96 periodicals, of which 66 are bought and 30 are presented. Of these, 25 are weekly, 4 are fortnightly, 43 are monthly, and 24 quarterly. They form altogether 108 volumes a year.

The Society now exchanges transactions with 179 Societies and public departments. These include the leading learned bodies in every quarter of the globe. During the year communication has been opened up with the South African Philosophical Society and the American Museum of Natural History.

Since last report 226 volumes have been bound. In all, the additions to the Library for the year amount to 233 volumes, 109 parts, and 7 pamphlets, making an estimated total of 12,456 volumes.

In Vol. XXVII. of the *Proceedings* there will be found a list of the additions to the Library by purchase up till June, 1896; the titles of the books presented, with the names of the donors; the names of the Societies and public departments with which exchanges are effected; and a list of the periodicals received at the Library.

During the autumn the rooms formerly occupied as the Curator's house have been adapted for Library purposes to meet the increasing demand for book space, and will be ready for occupation at an early date.

JOHN ROBERTSON, LIBRARIAN,
Convener.

7. The Chairman stated that there was a vacant Vice-Presidentship, owing to Dr. Coats' term of office having expired. The Council had recommended the election of Professor William Smart, LL.D., and he moved accordingly. Professor Smart was elected.

8. On the motion of the Chairman, Messrs. Mann and Robertson were re-elected as Hon. Treasurer and Hon. Librarian respectively. He subsequently stated that the Council had thought it desirable to revert to a former practice of the Society in regard to the Secretaryship—to have an Honorary Secretary as well as an Acting Secretary. For the former post the Council desired to nominate Dr. Freeland Fergus, who was willing to act in that capacity. His election was unanimously agreed to. In accordance with the recommendation of the Council, Mr. Mayer was unanimously elected Acting Secretary.

9. Four Members of Council—namely, ex-Bailie Wallace, Professor Barr, Mr. Mavor, and Mr. Somerville—fell to retire by rotation. For these vacancies, and for one caused by Dr. Fergus being elected to another office, five new Members had to be elected. The Council recommended Mr. J. F. Campbell, Mr. Walter W. Blackie, B.Sc., Mr. P. Falconer, Mr. James D. Borthwick, and Mr. W. B. Sayers, M.Inst.E.E., all of whom, on the motion of the Chairman, were elected—Mr. Sayers to serve for two years in succession to Dr. Fergus.

10. On the motion of Dr. G. A. Turner, the Council of the Geographical and Ethnological Section was reconstituted—Mr. Robert Gow being re-elected, Dr. Freeland Fergus to be a new Member of Council, and Dr. Robert Fullarton being re-elected Secretary and Treasurer of the Section.

11. The Council of the Sanitary and Social Economy Section was reconstituted, on the motion of Mr. James Chalmers, I.A., who was elected Hon. Secretary of the Section, in room of Mr. Church, who had resigned.

12. On the motion of Mr. H. A. Mavor, the Office-bearers of the Mathematical and Physical Section were re-elected for the year 1896-97.

13. In the absence of any responsible Office-bearer of the Economic Science Section, the Chairman moved the re-election of the Council of that Section, which was agreed to.

14. On the motion of Dr. David Ross, retiring President of the Philological Section, Dr. James Colville, M.A., was unanimously elected as his successor. The Council otherwise remained unchanged.

15. The Business of the Ordinary Meeting of the Society included the reading of a Paper by Professor W. H. Watkinson, Wh.Sch., M.Inst.Mech.E., M.Inst.E.E., Assoc.Inst.N.A., on "The Mechanical Propulsion of Tramway Cars," which was very fully illustrated by lantern views. A discussion ensued, in which the speakers were Professor Jamieson, Mr. Falconer, Mr. H. A. Mavor, Mr. W. Macleod, Mr. Richard Miller, and Mr. George Johnston. Professor Watkinson was heartily thanked for his communication, and made a brief reply.

16. The Chairman announced that the following Candidates for admission into the Society had all been elected:—

AS AN HONORARY MEMBER.

The Right Hon. Lord Kelvin, M.A., LL.D., D.C.L., F.R.S.

AS ORDINARY MEMBERS.

1. Mr. William Ure Harvey, Metal Broker, 56 Robertson Street, Glasgow.
2. Mr. George Chalmers, 13 Hamilton Crescent, Partickhill.
3. Mr. James J. Bell, Northcote, Dowanhill.
4. Mr. John T. Bell, Northcote, Dowanhill.
5. J. C. Simpson, M.D., 9 Marlborough Terrace, Kelvinside.

2nd December, 1896.

The Second Ordinary Meeting of the Philosophical Society of Glasgow was held in the Society's Rooms, 207 Bath Street, on the Evening of Wednesday, 2nd December, 1896, at Eight o'clock —Dr. Eben. Duncan, President, in the Chair.

1. The Minutes of Annual and Ordinary Meetings, held on 18th November, 1896, which were printed in the Billet calling the Meeting, were approved of, and signed by the Chairman.

2. The following new Ordinary Members, who were elected at the previous Meeting of the Society, were formally admitted:—

1. Mr. William Ure Harvey, Metal Merchant, 56 Robertson Street, Glasgow.
2. Mr. George Chalmers, 13 Hamilton Crescent, Partickhill.
3. Mr. James T. Bell, Northcote, Dowanhill.
4. Mr. John J. Bell, Northcote, Dowanhill.
5. J. C. Simpson, M.D., 9 Marlborough Terrace, Kelvinside.

3. Subsequently, the Right Hon. Lord Kelvin, M.A., LL.D., D.C.L., F.R.S., &c., who had that night completed a period of fifty years as an Ordinary Member, was admitted an Honorary Member of the Society, having been raised to that position by the unanimous vote of the Members, on the nomination of the Council.

4. The President then briefly recounted Lord Kelvin's connection with, and his work done for, the Society during the past fifty years, and at the close of his speech he presented Lord Kelvin with an address which had been prepared by the Council. The

address, which was read by Dr. Fergus, bore the signatures of the President, Hon. Treasurer, and Hon. Secretary. Lord Kelvin then made a suitable and very happy reply.

5. By way of making the occasion a notable one in the history of the Society, it had been resolved that a bronze portrait bust of Lord Kelvin should be presented to the Society from a special fund which had been raised amongst the Members. Mr. H. A. Mavor, as Convener of the Bust Committee, proceeded to make the presentation, at the same time unveiling the bust amid applause. At the close of his remarks, the President briefly acknowledged the gift on behalf of the Society. Professor Jack, on the part of the subscribers, then, in the course of an interesting speech, presented a replica of the bust to Lady Kelvin (who was present), Lord Kelvin briefly acknowledged the gift, and expressed her hearty thanks for the kindness of the donors. He was quite sure that Lady Kelvin would treasure it as a permanent memorial of the occasion and of their kindness to himself.

6. By arrangement with the Council, permission was given at this stage of the proceedings for the Electrical Engineers of the city to present an address to Lord Kelvin. The presentation was made on their behalf by Mr. John M. M. Munro, M.Inst.C.E., M.Inst.E.E., &c. This address was acknowledged by Lord Kelvin in very suitable terms.

7. Votes of thanks were then proposed :—By Dr. Fergus, to the artist, Mr. Shannan, who replied in a word; by Sheriff Berry, to the subscribers to the bust fund, Professor Ferguson replying; and by Professor G. G. Ramsay, to Dr. Duncan, for so ably conducting the proceedings.

8. The Chairman announced that all the candidates for admission into the Society named in the ballot paper—sixteen in number — had been elected. Their names, &c., are here given :—

1. Mr. George Johnston, Engineer, Mosesfield, Springburn. Recommended by Mr. Gilbert Thomson, Mr. John Mann, and Mr. Mayer.
2. Mr. Thomas Syminton, Solicitor, 94 Hope Street. Recommended by Mr. J. Craig Annan, Mr. Mann, and Mr. Mayer.
3. Mr. Thomas F. Agar, Argentine Consul-General, 7 Royal Bank Place. Recommended by Mr. J. C. Rogers, Mr. John Farquhar, and Mr. Mann.

4. Mr. A. M. MALLOCH, Glass Manufacturer, Firhill, Garscube Road. Recommended by Dr. Freeland Fergus, Mr. J. Rankin Brownlie, and Mr. A. C. Whyte.

5. Mr. DAVID W. BUCHAN, Sanitary Engineer, Fairy Knowe, Cambuslang. Recommended by Mr. P. Macgregor Chalmers, Mr. F. T. Barrett, and Mr. Gilbert Thomson.

6. Mr. JOHN TURPIE, Electrician, 339 Sauchiehall Street. Recommended by Mr. William Adam, Mr. James Keane, and Dr. Freeland Fergus.

7. Dr. JAMES HINSHELWOOD, M.A., 9 Elmbank Street. Recommended by Mr. P. Macgregor Chalmers, Dr. Fergus, and Mr. Mayer.

8. Mr. ANDREW MITCHELL, C.A., 187 West George Street. Recommended by Mr. Robert Lamond, Mr. F. N. Sloane, and Mr. Joseph Patrick.

9. Mr. F. W. PAUL, Steel Works Manager, Mount Vernon. Recommended by Professor Sexton, Mr. Mayer, and Dr. Fergus.

10. Mr. STEPHEN ADAM, Glass Stainer, 199 Bath Street. Recommended by Mr. Mayer, Mr. P. Macgregor Chalmers, and Mr. T. L. Watson.

11. Mr. A HENDERSON BISHOP, Merchant, 32 Herbert Street. Recommended by Professor J. Robertson Watson, Mr. John Henderson, and Mr. Mayer.

12. Mr. J. M. M. MUNRO, M.Inst.E.E., M.Inst.C.E., F.R.S.E., 136 Bothwell Street. Recommended by Mr. Henry A. Mavor, Dr. Fergus, and Mr. Mayer.

13. Mr. WM. D. GILMOUR, 229 Byars Road. Recommended by Mr. David Lamb, Mr. Mann, and Mr. Gilbert Thomson.

14. Mr. DANIEL MURRAY, Contractor, 4 East Park Terrace, Maryhill. Recommended by Mr. J. F. Campbell, Mr. J. M'Kellar, and Mr. Mann.

15. Mr. JAMES NEILSON, 116 Bishop Street, Port-Dundas. Recommended by Mr. J. M'Kellar, Mr. John Dansken, and Mr. J. F. Campbell.

16. Dr. J. KENNEDY DALZIEL, 196 Bath Street. Recommended by Dr. Freeland Fergus, Mr. Oswald Fergus, and Mr. Mayer.

9. The Members and their lady friends and other visitors then adjourned to the Library, where tea and coffee were served.

16th December, 1896.

The Third Ordinary Meeting of the Philosophical Society of Glasgow was held in the Society's Rooms, 207 Bath Street, on the Evening of Wednesday, 16th December, 1896, at Eight o'clock—Dr. Eben. Duncan, President, in the Chair.

1. The Minutes of the Second Ordinary Meeting, held on 2nd December, 1896, which were printed in the Billet calling the Meeting, were approved of, and signed by the Chairman.

2. The following new Members, who were elected at the previous Meeting of the Society, were formally admitted :—

1. Mr. George Johnston, Engineer, Mosesfield, Springburn.
2. Mr. Thomas Syminton, Solicitor, 94 Hope Street.
3. Mr. Thomas F. Agar, Argentine Consul-General, 7 Royal Bank Place.
4. Mr. A. M. Malloch, Glass Manufacturer, Firhill, Garscube Road.
5. Mr. David W. Buchan, Sanitary Engineer, Fairy Knowe, Cambuslang.
6. Mr. John Turpie, Electrician, 339 Sauchiehall Street.
7. Dr. James Hinshelwood, M.A., 9 Elmbank Street.
8. Mr. Andrew Mitchell, C.A., 187 West George Street.
9. Mr. F. W. Paul, Steel Works Manager, Mount Vernon.
10. Mr. Stephen Adam, Glass Stainer, 199 Bath Street.
11. Mr. A. Henderson Bishop, Merchant, 32 Herbert Street.
12. Mr. J. M. M. Munro, M.Inst.E.E., M.Inst.C.E., F.R.S.E., 136 Bothwell Street.
13. Mr. Wm. D. Gilmour, 229 Byars Road.
14. Mr. Daniel Murray, Contractor, 4 East Park Terrace, Maryhill.
15. Mr. James Neilson, 116 Bishop Street, Port-Dundas.
16. Dr. J. Kennedy Dalziel, 196 Bath Street.

3. Dr. J. G. M'Kendrick, F.R.S., then proceeded to deliver a Lecture on "A Study of Sound and Speech Waves as revealed by the Phonograph," which was attentively listened to by a large audience. It was extensively illustrated by Lantern Views and Experiments, and at the close, on the motion of the Chairman, a very cordial vote of thanks was awarded to Dr. M'Kendrick for his most interesting Lecture.

4. The Chairman announced the election of the following Candidates for Membership of the Society :—

1. Mr. T. O. Mathieson, Manufacturer, 3 Grosvenor Terrace. Recommended by Dr. Freeland Fergus, Mr. J. Craig Annan, and Mr. Oswald Fergus.
2. Mr. A. M'Farlane Shannan, Artist-Sculptor, 7 Scott Street, Garnethill. Recommended by Dr. Freeland Fergus, Mr. Oswald Fergus, and Mr. Mayer.
3. Mr. William G. Crum, Thornliebank. Recommended by Lord Kelvin, Dr. J. T. Bottomley, and Professor John Ferguson.
4. Mr. Lewes R. Crosskey, Art Master, 34 Wilton Gardens. Recommended by Mr. P. Macgregor Chalmers, Dr. Freeland Fergus, and Mr. Mayer.

6th January, 1897.

The Fourth Ordinary Meeting of the Philosophical Society of Glasgow was held in the Society's Rooms, 207 Bath Street, on

the Evening of Wednesday, 6th January, 1897, at Eight o'clock —Dr. Eben. Duncan, President, in the Chair.

1. The Minutes of the Third Ordinary Meeting, held on 16th December, 1896, which were printed in the Billet calling the Meeting, were approved of, and signed by the Chairman.

2. The following new Members, who were elected at the previous Meeting of the Society, were formally admitted:—

1. Mr. T. O. MATHIESON, Manufacturer, 8 Grosvenor Terrace.
2. Mr. M'FARLANE SHANNAN, Artist-Sculptor, 7 Scott Street, Garnethill.
3. Mr. WILLIAM G. CRUM, Thornliebank.
4. Mr. LEWES R. CROSSKEY, Art Master, 34 Wilton Gardens.

Letter from Lady Kelvin.

3. The Hon. Secretary read the following letter which had been received from Lady Kelvin, and had been laid before the Council. It was agreed that it should be embodied in the minutes, and printed in the *Proceedings*:—

"The University,
"Glasgow, January 4th, 1897.

"DEAR Dr. FERGUS,

"I feel that I ought sooner to have expressed my gratitude for the replica of the Bust of Lord Kelvin which has been given to me by his kind friends of the Philosophical Society; but I have been away from home, which must partly account for my seeming neglect.

"We have returned home to-day, and when I again see the Bust and feel how well it fulfils the purpose of the kind friends to whom it is due, I can no longer delay writing to you to say how very much I like it, and how happy I am to possess it, and to know what a valuable heirloom it will be in the family.

"May I ask you to convey my warmest thanks to the Philosophical Society, and to tell them how much I value their gift?

"I remain,
"Yours very truly,
(Signed) "F. A. KELVIN."

4. Dr. John Glaister, F.F.P.S.G., D.P.H.(Camb.), &c., Professor of Medical Jurisprudence and Public Health, St. Mungo's College, President of the Sanitary and Social Economy Section, delivered his Presidential Address, the subject of which was "The Pollution of Scottish Rivers." The address was of a very comprehensive and interesting character. Mr. James Chalmers, Secretary of the Section, made some remarks on the subject dealt with, and moved a vote of thanks to Dr. Glaister. The Chairman

likewise spoke on the subject, and seconded the vote of thanks. He also moved that it be remitted to the Council to consider as to memorialising the Local Government Board in favour of amendment of the Act of Parliament bearing on the question of the Pollution of Scottish Rivers. Dr. Glaister acknowledged the vote of thanks, and seconded the Chairman's motion, which was carried.

5. The Chairman announced the election of the following Candidates for Membership of the Society :—

1. Mr. J. A. Duncan, Merchant, Glenlee, Bridge-of-Allan. Recommended by Dr. Freeland Fergus, Dr. M'Kendrick, and Mr. P. Macgregor Chalmers.
2. Dr. Thomas John Burton, Lonsdale, Bearsden. Recommended by Mr. W. B. Sayers, Mr. Arthur J. Davey, and Mr. Sam. Mavor.
3. Mr. John Stewart, Wright, 220 Parliamentary Road. Recommended by Mr. P. Macgregor Chalmers, Dr. Freeland Fergus, and Mr. Mayer.
4. Mr. William Gibson, Builder, 2 Wilton Mansions. Recommended by Dr. Thomas Richmond, Mr. P. Macgregor Chalmers, and Mr. Mayer.
5. Geo. Henry Edington, M.D., M.R.C.S.(Eng.), 14 Buckingham Terrace. Recommended by Dr. Freeland Fergus, Mr. J. Craig Annan, and Dr. J. B. Russell.

20th January, 1897.

The Fifth Ordinary Meeting of the Philosophical Society of Glasgow was held in the Society's Rooms, 207 Bath Street, on the Evening of Wednesday, 20th January, 1897, at Eight o'clock —Dr. Eben. Duncan, President, in the Chair.

1. The Minutes of the Fourth Ordinary Meeting, held on 6th January, 1897, which were printed in the Billet calling the Meeting, were approved of, and signed by the Chairman.

2. The following new Members, who were elected at the previous Meeting of the Society, were formally admitted :—

1. Mr. J. A. Duncan, Merchant, Glenlee, Bridge-of-Allan.
2. Dr. Thomas John Burton, Lonsdale, Bearsden.
3. Mr. John Stewart, Wright, 220 Parliamentary Road.
4. Mr. William Gibson, Builder, 2 Wilton Mansions.
5. Geo. Henry Edington, M.D., M.R.C.S.(Eng.), 14 Buckingham Terrace.

3. Dr. J. C. M'Vail read a paper on "The Vaccination Commission's Report: A Plea for Revaccination." A discussion

followed, in which Mr. P. Falconer, Mr. W. J. Begg (Secretary to the Anti-vaccination Association), and the President took part. On the motion of the Honorary Secretary, a cordial vote of thanks was passed to Dr. M'Vail.

4. Professor A. H. Sexton read a paper on "The Andersonian: A Centenary Note," which was received with much satisfaction, and for which he was awarded the thanks of the Society.

5. The Chairman announced the election of the following Candidate for Membership of the Society:—

Mr. THOMAS M'ARLY, Calico Printer, 29 West George Street. Recommended by Mr. George Handasyde Dick, Dr. Freeland Fergus, and Mr. Mayer.

3rd February, 1897.

The Sixth Ordinary Meeting of the Philosophical Society of Glasgow was held in the Society's Rooms, 207 Bath Street, on the Evening of Wednesday, 3rd February, 1897, at Eight o'clock—Mr. F. T. Barrett, Vice-President, in the Chair.

1. The Minutes of the Fifth Ordinary Meeting, held on 20th January, 1897, which were printed in the Billet calling the Meeting, were approved of, and signed by the Chairman.

2. The following new Member, who was elected at the previous Meeting of the Society, was formally admitted:—

Mr. THOMAS M'ARLY, Calico Printer, 29 West George Street.

3. Dr. James Colville, M.A., read a paper on "The Text of Burns," which was very fully illustrated by lantern views. At its close, he was awarded a very cordial vote of thanks, on the motion of the Chairman.

4. The Chairman announced the election of the following Candidate for Membership of the Society:—

Mr. THOMAS W. CUTHBERTSON, M.A., 25 Blythswood Square. Recommended by Dr. Freeland Fergus, Mr. Oswald Fergus, and Mr. James Craig Annan.

17th February, 1897.

The Seventh Ordinary Meeting of the Philosophical Society of Glasgow was held in the Society's Rooms, 207 Bath Street, on the Evening of Wednesday, 17th February, 1897, at Eight

o'clock—Mr. Gilbert Thomson, M.A., C.E., Vice-President, in the Chair.

1. The Minutes of the Sixth Ordinary Meeting, held on 3rd February, 1897, which were printed in the Billet calling the Meeting, were approved of, and signed by the Chairman.

2. Mr. Thomas W. Cuthbertson, M.A., 24 Blythswood Square, was formally admitted as a new Member.

3. Mr. John G. Kerr, M.A., Headmaster of Allan Glen's School, read a paper on "Educational Experiments," which was listened to by a large and interested audience. A discussion followed, the speakers in which included Dr. W. T. Gairdner, F.R.S.; Professor William Jack, M.A.; Mr. Richard G. Ross; Mr. John Young, M.A., B.Sc.; and Mr. H. A. Mavor. A cordial vote of thanks was passed to Mr. Kerr for his paper.

24th February, 1897.

A Special Meeting of the Society was held in the Society's Rooms, 207 Bath Street, on the Evening of Wednesday, 24th February, at Eight o'clock—Professor William Smart, Vice-President, in the Chair.

Mr. George Handasyde Dick, as President of the Economic Science Section, read a paper on "Some Aspects of Political Economy from a Commercial Point of View." In the discussion which followed the paper, the speakers included Mr. W. W. Blackie, Mr. Nathaniel Dunlop, the Chairman, and Mr. John A. Todd, of the Athenæum. Mr. Dick replied to the speakers, and, on the motion of the Chairman, he was awarded the best thanks of the Society for his address.

3rd March, 1897.

The Eighth Ordinary Meeting of the Philosophical Society of Glasgow, was held in the Society's Rooms, 207 Bath Street, on the Evening of Wednesday, 3rd March, 1897, at Eight o'clock—Dr. Eben. Duncan, President, in the Chair.

1. The Minutes of the Seventh Ordinary Meeting, held on 17th February, 1897, which were printed in the Billet calling the Meeting, were approved of, and signed by the Chairman.

2. Mr. James R. Greig, of Messrs. Gregor, Turnbull, & Co., read a paper on "The Sugar Bounties," which led to a most important discussion. The speakers included Mr. Alex. Graham, Mr. Mitchell, Mr. Barclay, Mr. Macdonald, Mr. Falconer, Mr. Neill (Greenock), Dr. Smart, and Mr. Wilson. Mr. Greig made a short reply, after which the Chairman made a few remarks, and proposed a vote of thanks to the author of the paper.

17th March, 1897.

The Ninth Ordinary Meeting of the Philosophical Society of Glasgow was held in the Society's Rooms, 207 Bath Street, on the Evening of Wednesday, 17th March, 1897, at Eight o'clock— Dr. Eben. Duncan, President, in the Chair.

1. The Minutes of the Eighth Ordinary Meeting, held on 3rd March, 1897, which were printed in the Billet calling the Meeting, were approved of, and signed by the Chairman.

2. Dr. John Macintyre, F.R.S.E., gave a "Demonstration on the X Rays, being a Resumé of Experiments since his former Demonstrations before the Society." He received the best thanks of the Society for his demonstration.

3. The Chairman announced that the following gentlemen, whose names had appeared in the ballot paper, had all been elected members of the Society :—

1. Mr. John Robb, Calico Printer, Busby House, Busby. Recommended by Mr. Geo. Handasyde Dick, Dr. William Smart, and Dr. Freeland Fergus.
2. Mr. David M'Donald, Wine Merchant, 11 Huntly Gardens, Kelvinside. Recommended by Mr. John T. Costigane, J.P., Mr. John Steven, and Mr. Mayor.
3. Mr. Walter Bergius, C.E., Queen Street. Recommended by Mr. Geo. Handasyde Dick, Professor Smart, and Mr. Robert Lamond.
4. Mr. David Bruce, M.A., LL.B., Writer, 49 West George Street. Recommended by Mr. Geo. Handasyde Dick, Professor Smart, and Mr. Robert Lamond.

31st March, 1897.

The Tenth Ordinary Meeting of the Philosophical Society of Glasgow was held in the Society's Rooms, 207 Bath Street, on the Evening of Wednesday, 31st March, 1897, at Eight o'clock—Dr. Eben. Duncan, President, in the Chair.

1. The Minutes of the Ninth Ordinary Meeting, held on 17th March, 1897, which were printed in the Billet calling the Meeting, were approved of, and signed by the Chairman.

2. The following new Members were admitted:—

1. Mr. John Robb, Calico Printer, Busby House, Busby.
2. Mr. David M'Donald, Wine Merchant, 11 Huntly Gardens, Kelvinside.
3. Mr. Walter Bergius, C.E., Queen Street.
4. Mr. David Bruce, M.A., LL.B., Writer, 49 West George Street.

3. Professor Arch. Barr., D.Sc., Mem.Inst.C.E., read a paper on "Range-finders," and exhibited the instrument invented conjointly by himself and by Professor Stroud, of the Yorkshire College, Leeds. He received a cordial vote of thanks for his communication.

4. The Chairman announced that the gentlemen whose names had appeared in the ballot paper had all been elected members of the Society. They were as follow:—

1. Mr. William Connell, jun., Plumber, Coldstream, Cathkin Road, Langside. Recommended by Mr. William Ross, Mr. W. U. Harvey, and Mr. Wm. A. Rattray.
2. Mr. James R. Greig, Merchant, Claremont, Langside. Recommended by Dr. Eben. Duncan, Dr. Freeland Fergus, and Mr. Mayer.
3. Mr. Edward H. Parker, Secretary, Institution of Engineers and Shipbuilders in Scotland. Recommended by Mr. James Mollison, Dr. Fergus, and Mr. Mayer.

14th April, 1897.

The Eleventh Ordinary Meeting of the Philosophical Society of Glasgow was held in the Society's Rooms, 207 Bath Street, on the Evening of Wednesday, 14th April, 1897, at Eight o'clock—Dr. Eben. Duncan, President, in the Chair.

1. The Minutes of the Tenth Ordinary Meeting, held on 31st March, 1897, which were printed in the Billet calling the Meeting, were approved of, and signed by the Chairman.

2. The following new Members were admitted :—

1. Mr. William Connell, Jun., Plumber, Coldstream, Cathkin Road, Langside.
2. Mr. James R. Greig, Merchant, Claremont, Langside.
3. Mr. Edward H. Parker, Secretary, Institution of Engineers and Shipbuilders in Scotland.

3. Dr. J. C. Beattie, of the University Physical Laboratory, made a communication to the Society on "Röntgen Rays, and on the Photographic and Electrical Effects due to Uranium." A discussion took place, in which Mr. Sayers and Mr. Falconer took part. Dr. Beattie was awarded the best thanks of the Society.

28th April, 1897.

The Twelfth and Last Ordinary Meeting of the Philosophical Society of Glasgow was held on Wednesday, 28th April, 1897, at Eight o'clock, in the Large Hall of the Society, 207 Bath Street—Dr. Eben. Duncan, President, in the Chair.

1. The Minutes of the Eleventh Ordinary Meeting of the Society, which were printed in the Billet calling the Meeting, were approved of, and signed by the Chairman.

2. Mr. John Donald, Headmaster, Townhead Public School, read a paper on "Calculations concerning Time and Weight," which led to an interesting discussion amongst the Members. Mr. Donald was thanked for his paper.

3. Mr. Leslie Paton, B.A., Cambridge University, subsequently read a paper on "Theories of Life," for which he was heartily thanked.

4. The President announced that the following Candidates had been elected Members of the Society, namely :—

1. Mr. William W. Carlile, M.A., Hailie, Largs, Ayrshire. Recommended by Professor W. Smart, Dr. Freeland Fergus, and Mr. Mayer.
2. Mr. George Ballantyne, Jun., Wine Merchant, 100 Union Street. Recommended by Mr. W. B. Sayers, Mr. Gilbert Thomson, and Mr. Geo. Handasyde Dick ;—

and he then dismissed the Society for the Summer Recess.

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OF THE

PHILOSOPHICAL SOCIETY OF GLASGOW.

SESSION 1896-97.

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* *Retire by rotation in November, 1897.*

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Those marked thus (*) retire by rotation in November, 1897.

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ADDITIONS TO THE LIBRARY.

Donations, in addition to the Works received in Exchange from the Societies, &c., named on pp. 332-340.

Memorials of the Faculty of Physicians and Surgeons of Glasgow, 1599-1850. By Alexander Duncan. 4to. Glasgow, 1896. From Dr. Freeland Fergus.

Vaccination, Final Report of the Royal Commission appointed to inquire into the subject of. Folio. London, 1896. From Dr. Freeland Fergus.

In Memoriam. George Mather, M.D. 8vo. Glasgow, 1896. From Dr. Freeland Fergus.

Small Portrait of Professor Joseph Black, M.D., at one time Professor of Chemistry in the University ef Glasgow. From Dr. F. Fergus.

Dead-Meat Inspection : the Detective System *v.* the Clearing-House System. By J. B. Russell. Address to the Sanitary Association of Scotland, 1896. From the Author.

The Physical Laws which Govern the Distribution of Infection : an Address to the British Institute of Public Health, Glasgow, 1896. By J. B. Russell. From the Author.

Official Directory of the Chartered Accountants of Scotland, 1896-97. From the Council.

Fossil Sponges and other Organic Remains from the Quebec Group at Little Metis on the Lower St. Lawrence. By Sir J. W. Dawson. With notes on some of the specimens, by G. J. Hinde. 8vo Pamphlet, 1896. From the Author.

International Geological Congress Map of Europe. Sheets A5, A6, B5, B6, C6. From Geological Survey of United Kingom.

James Finlayson. An Account of the Life and Works of Dr. Robert Watt. 8vo. London, 1897. From the Author.

Portrait of Dr. Robert Watt, President of the Society, 1816-17. From Dr. James Finlayson.

Dick, G. Handasyde. Bi-metallism Popularised. Small 4to. Glasgow, 1896. From the Author.

Annual Report of Fulham Free Public Library, 1896. From the Librarian.

Report of the Proceedings of the Conference on Inland Navigation, with Map of English Canals. Birmingham, 1895. From Federated Institution of Engineers.

Flora of Dumfriesshire, including part of the Stewartry of Kirkcudbright. By G. F. Scott-Elliot. 8vo. Dumfries, 1896. From the Author.

A Naturalist in Mid-Africa, being an account of a journey to the Mountains of the Moon and Tanganyika. By G. F. Scott-Elliot. 8vo. London, 1896. From the Author.

The Accountants' Magazine. No. 1, January, 1897. 8vo. Edinburgh. From the Editor.

Widows' and Pension Funds: containing Statistical and Monetary Tables based on the results of an investigation of the Marriage and Mortality experience of the Widows' Funds of the Scottish Banks. By Archibald Hewat. 8vo. London, 1896. From the Author.

Methods for the determination of Organic Matter in the Air. By D. H. Bergey. (Smithsonian Miscellaneous Collections, No. 1037.) From Smithsonian Institution.

Index to the Genera and Species of the Foraminifera. Part II. (Non—Z.) By C. D. Sherborn. (Smithsonian Miscellaneous Collections, No. 1031.) From Smithsonian Institution.

Oceanic Ichthyology. A Treatise on the Deep-Sea and Pelagic Fishes of the World, with Atlas. By Goode and Bean. (Smithsonian Contributions to Knowledge. Vols. XXX., XXXI.) From Smithsonian Institution.

Report of the Museums and Galleries of the Corporation of Glasgow, 1896. From the Superintendent.

Researches on the Evolution of the Stellar System. Vol. I. On the Universality of the Law of Gravitation and on the Orbits and General Characteristics of Binary Stars. By T. J. J. See. 4to. Lynn, Mass. From the Author.

Reports from the Laboratory of the Royal College of Physicians, Edinburgh. Edited by J. B. Tuke and D. N. Paton. Vol. VI. 8vo. Edinburgh, 1897. From the Librarian.

Reports and Transactions of the Guernsey Society of Natural Science and Local Research, 1882-95, and continued. 8vo. Guernsey. From the Society.

Geological Survey of Scotland. Maps Nos. 20 and 103. 1-inch scale. Explanation of Sheet 75. From Geological Survey.

Smithsonian Institution's Publications—

- Argon, a new Constituent of the Atmosphere. By Lord Rayleigh and Prof. W. Ramsay. (Smithsonian Contributions to Knowledge, No. 1033.) From Smithsonian Institution.
- Smithsonian Tables. By Thomas Gray. From Smithsonian Miscellaneous Collections. Vol. XXXV. 1896.
- Virginia Cartography: a Bibliographical Description. By P. Lee Phillips. From Smithsonian Miscellaneous Collections. Vol. XXXVII. 1896.
- Mountain Observatories in America and Europe. By E. S. Holden. 1896. From Smithsonian Miscellaneous Collections. Vol. XXXVII.
- Constants of Nature. Part V. A Recalculation of the Atomic Weights. By F. W. Clarke. New Edition, 1897. From Smithsonian Miscellaneous Collections. Vol. XXXVIII.
- Air and Life. By H. De Varigny. 1896. From Smithsonian Miscellaneous Collections. Vol. XXIX.
- The Atmosphere in Relation to Human Life and Health. By F. A. R. Russell. 1896. From Smithsonian Miscellaneous Collections. Vol. XXIX.

The Air of Towns. By J. B. Cohen. 1896. From Smithsonian Miscellaneous Collections. Vol. XXIX.

Atmospheric Actinometry and the Actinic Constitution of the Atmosphere. 1896. By E. Duclaux. From Smithsonian Contributions to Knowledge. Vol. XXIX.

Equipment and Work of an Aero-Physical Observatory. By A. M'Adie. 1897. From Smithsonian Miscellaneous Collections. Vol. XXIX.

Report of Stirling's and Glasgow Public Library, 1896-97. From the Librarian.

Distribution of Tuberculous Disease in Glasgow, with Observations on the Relation of Phthisis to Room-density. By Dr. A. K. Chalmers. 8vo Pamphlet, 1897. From the Author.

Books added to the Library by Purchase.

Dictionary of National Biography. Vols. XLVIII.-L.

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,, II.—Biographical Essays.

,, III.—Essays on Language and Literature.

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Foraminifera of the Crag. Part III. By F. R. Jones.

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Burton, J. H. History of Scotland, from Agricola's Invasion to the extension of the last Jacobite Insurrection. New Edition. 8 vols. and Index vol. 8vo. Edinburgh.

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Vol. IV. From James I. to death of Anne.

Vol. V. From George I. to Battle of Waterloo.

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Kingsley, Mary H. Travels in West Africa, 8vo. London, 1897.

Morgan, C. L. Habit and Instinct. 8vo. London, 1896.

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Smith, Adam. An Inquiry into the Nature and Causes of the Wealth of Nations. 2 vols. 8vo. London, 1892-96.

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THE PHILOSOPHICAL SOCIETY EXCHANGES WITH THE FOLLOWING SOCIETIES, &c.:—

AFRICA.

Cape Town—

South African Philosophical Society.

AUSTRALIA.

Brisbane—

Royal Geographical Society of Australasia (Queensland Branch).

Melbourne—

Royal Observatory Library.

Patent Office.

Royal Society of Victoria.

AUSTRALIA—*continued.*

Sydney—
Department of Mines.
Royal Geographical Society of Australasia (New South Wales Branch).
Royal Society of New South Wales.
Technological Museum.

BELGIUM.

Brussels—
Académie Royale des Sciences.
Observatoire Royale.
Société Malacologique de Belgique.

Liège—
Société Royale des Sciences.

CANADA.

Halifax—
Nova Scotian Institute of Science.

Hamilton (Ont.)—
Hamilton Association.

London (Ont.)—
Entomological Society of Ontario.

Montreal—
Canadian Society of Civil Engineers.
Geological and Natural History Survey of Canada.
Royal Society of Canada.

Quebec—
Literary and Historical Society.

Toronto—
Canadian Institute.

Winnipeg—
Manitoba Historical and Scientific Society.

CHINA.

Hong Kong—
Hong Kong Observatory.

ENGLAND AND WALES.

Barnsley—
Midland Institute of Mining, Civil, and Mechanical Engineers.

Bath—
Bath Natural History and Antiquarian Field Club.

Berwick—
Berwickshire Naturalists' Field Club.

Birkenhead—
Birkenhead Literary and Scientific Society.

Birmingham—
Philosophical Society.

ENGLAND AND WALES—*continued.*

Bristol—
Bristol Naturalists' Society.

Cambridge—
Philosophical Society.
University Library.

Cardiff—
Cardiff Naturalists' Society.

Essex—
Essex Field Club.

Falmouth—
Royal Cornwall Polytechnic Society.

Folkestone—
Folkestone Natural History Society.

Greenwich—
Royal Observatory.

Leeds—
Leeds Philosophical and Literary Society.

Leicester—
Leicester Literary and Philosophical Society.

Liverpool—
Geological Society.
Historic Society of Lancashire and Cheshire.
Literary and Philosophical Society.
Liverpool Engineering Society.
Liverpool Naturalists' Field Club.

London—
Anthropological Institute.
British Association for the Advancement of Science.
British Museum.
British Museum (Nat. Hist.).
Chemical Society.
Institution of Civil Engineers.
Institution of Mechanical Engineers.
Junior Engineering Society.
Middlesex Hospital.
Patent Office Library.
Pharmaceutical Society.
Royal Geographical Society.
Royal Institute of British Architects.
Royal Institution of Great Britain.
Royal Meteorological Society.
Royal Photographic Society.
Royal Society.
Royal Statistical Society.
Society of Arts.

ENGLAND AND WALES—*continued.*

London (*continued*)—
Society of Biblical Archæology.
Society of Engineers.
Society of Psychical Research.
The *Lancet.*
Engineering.
Industries and Iron.

Manchester—
Manchester Association of Engineers.
Geographical Society.
Literary and Philosophical Society of Manchester.

Middlesborough—
Cleveland Institution of Engineers.

Newcastle-upon-Tyne—
North-East Coast Institution of Engineers and Shipbuilders.
North of England Institute of Mining and Mechanical Engineers.
Society of Chemical Industry.

Swansea—
South Wales Institute of Engineers.

Truro—
Royal Institution of Cornwall.

Watford—
Hertfordshire Natural History Society and Field Club.

Welshpool—
Powys Land Club.

FRANCE.

Bordeaux—
Société des Sciences Physiques et Naturelles.

Marseilles—
Faculté des Sciences de Marseille.

Paris—
École Polytechnique.
Observatoire Météorologique Central de Montsouris.

GERMANY.

Berlin—
Deutsche Chemische Gesellschaft.
Deutscher Kolonial Verein.
Königlich Preussische Akademie der Wissenschaften.

Bremen—
Geographische Gesellschaft.

Giessen (Hesse)—
Oberhessische Gesellschaft für Natur-und Heilkunde.

Griefswald (Prussia)—
Geographische Gesellschaft.

GERMANY—*continued.*

Halle (Prussia)—
Verein für Erdkunde.
Kaiserliche Leopoldina—Carolina Akademie der Deutschen Naturforscher.

Hamburg—
Geographische Gesellschaft.

INDIA.

Calcutta—
Geological Survey of India.

IRELAND.

Belfast—
Belfast Naturalists' Field Club.
Natural History and Philosophical Society.

Dublin—
Royal Dublin Society.
Royal Irish Academy.

ITALY.

Milan—
Reale Instituto di Lombardo.

JAPAN.

Tokio—
Imperial University of Japan (College of Medicine).
Seismological Society of Japan.
University of Tokio.

MEXICO.

Mexico—
Observatorio Astronómico Nacional de Tacubaya.
Sociedad Cientifica "Antonio Alzate."

NEW ZEALAND.

Wellington—
Colonial Museum.

NETHERLANDS.

Amsterdam—
Academie Royale des Sciences.

Harlem—
La Société des Sciences á Harlem.
Teyleryan Library.

Leyden—
Kon. Nederlandisch Aardrijkskundig Genootschap.

NORWAY.

Christiania—
Kongelige Norske Universitet.

PORTUGAL.

Lisbon—
Academia Real das Sciencias.

ROUMANIA.

Bucharest—
Societaţiĭ de Sciinte Fizice.

RUSSIA.

Kazan—
Imperial Kazan University.

St. Petersburg—
Académie Impériale des Sciences.
Russian Chemical Society of the University of St. Petersburg.

SCOTLAND.

Aberdeen—
Philosophical Society.

Edinburgh—
Advocates' Library.
Geological Society.
Highland and Agricultural Society of Scotland.
Royal Botanic Gardens.
Royal Physical Society.
Royal Scottish Geographical Society.
Scottish Meteorological Society.
Royal Scottish Society of Arts.
Royal Society.

Glasgow—
Archæological Society.
Baillie's Institution Free Library.
Faculty of Physicians and Surgeons of Glasgow.
Geological Society.
Glasgow and West of Scotland Technical College Library.
Institution of Engineers and Shipbuilders in Scotland.
Mitchell Library.
Natural History Society of Glasgow.
Stirling's Public Library.

Greenock—
Philosophical Society.

Hamilton—
Mining Institute of Scotland.
Public Library.

Paisley—
Public Library.

SWEDEN.

Upsala—
Geological Institution of the University of Upsala.

Stockholm—
Kongliga Svenska Vetenskaps-Akademien.

TASMANIA.

Hobart—
Royal Society of Tasmania.

UNITED STATES.

Austin (Texas)—
Texas Academy of Science.

Baltimore—
Johns Hopkins University.

Boston—
American Academy of Arts and Sciences.
Public Library.
Society of Natural History.

Cincinnati—
Ohio Mechanics' Institute.

Davenport (Iowa)—
Academy of Natural Sciences.

Madison—
Washburn Observatory.

Minneapolis—
Geological and Natural History Society of Minnesota.

Newhaven (Conn.)—
Connecticut Academy of Arts and Sciences.

New York—
American Geographical Society.
American Museum of Natural History.
American Society of Civil Engineers.
Astor Library.
New York Academy of Sciences.
School of Mines, Columbia College.

Philadelphia—
Academy of Natural Science of Philadelphia.
Alumni Association.
American Pharmaceutical Association.
American Philosophical Society.
Franklin Institute.
Numismatic and Antiquarian Society of Philadelphia.
Wagner Free Institute of Science.

Portland (Maine)—
Portland Society of Natural History.

Rochester (N. Y.)—
Rochester Academy of Science.

St. Louis—
Academy of Science.
Public School Library.

UNITED STATES—*continued.*

San Francisco (California)—
California Academy of Sciences.

Topeka (Kansas)—
Kansas Academy of Science.

Trenton (N. J.)—
Trenton Natural History Society.

Washington—
Bureau of Education (Department of the Interior).
Bureau of Ethnology.
Smithsonian Institution.
United States Geological Survey.
United States National Museum (Department of the Interior).
United States Naval Observatory.

LIST OF PERIODICALS.

(Those received in exchange are indicated by an asterisk.)

WEEKLY.

Academy.
Architect.
Athenæum.
British Architect.
British Journal of Photography.
Builder.
Builders' Journal.
Building News.
Chemical News.
Comptes Rendus.
*Dingler's Polytechnisches Journal.
Economist.
Electrical Review.
Electrician.
Engineer.
*Engineering.
English Mechanic.
*Industries and Iron.
*Journal of the Society of Arts.
Journal of Gas Lighting, &c.
*Lancet.
Nature.
Notes and Queries.
*Pharmaceutical Journal.
Publishers' Circular.
Scientific American and Supplement.

FORTNIGHTLY.

Annalen der Chemie (Liebig's).
*Berichte der Deutschen Chemischen Gesellschaft.
Journal für Praktische Chemie (Erdmann's).
Zeitschrift für Angewandte Chemie.

MONTHLY.

*American Chemical Journal.
Analyst.
Annalen der Physik und Chemie.
Annales de Chimie et de Physique.
Annales de l'Institut Pasteur.
Annales des Ponts et des Chaussées.
Annales des Sciences Naturelles. Botanique.
Annales des Sciences Naturelles. Zoologie.
Annals and Magazine of Natural History.
Antiquary.

Beiblätter zu den Annalen der Physik und Chemie.
Bookseller.
Bulletin de la Société Chimique de Paris.
Bulletin de la Société d'Encouragement.
Bulletin de la Société Géologique de France.
Bulletin de la Société Industrielle de Mulhouse.
*Bulletin Mensuel de l'Observatoire de Montsouris.
*Canadian Entomologist.
*Deutsche Kolonialzeitung.
Entomologist.
Entomologists' Monthly Magazine.
*Geographical Journal.
Geological Magazine.
*Johns Hopkins University Circulars.
Journal de Pharmacie et de Chimie.
Journal of Botany.
*Journal of the Chemical Society.
*Journal of the Franklin Institute.
*Journal of the Photographic Society.
*Journal of the Society of Chemical Industry.
London, Edinburgh, and Dublin Philosophical Magazine.
*Monatsbericht der Königlich Preussischen Akademie der Wissenschaften zu Berlin.
Monthly List of Official and Parliamentary Papers.
Petermanns Mitteilungen.
Polytechnic Bibliothek.
*Proceedings of Royal Society of London.
*Proceedings of the Society of Biblical Archæology.
Revue Universelle des Mines.
*Royal Astronomical Society's Monthly Notices.
Sanitary Journal.
Science Gossip.
*Scottish Geographical Magazine.
Zoologist.

QUARTERLY.

Annales des Mines.
Annals of Botany.
Annals of Scottish Natural History.
*Archives Nèerlandaises des Sciences Exactes et Naturelles.
*Bulletin of the American Geographical Society.
Economic Journal.
Forschritte der Mathematik.
Journal of Anatomy and Physiology.
*Journal of the Anthropological Institute of Great Britain.
*Journal of Manchester Geographical Society.
Journal of the Royal Agricultural Society of England.
Journal of the Royal Microscopical Society.
*Journal of the Royal Statistical Society.
*Journal of the Scottish Meteorological Society.
La Nature.
Mind: a Quarterly Review of Psychology and Philosophy.
Quarterly Journal of Economics.
Quarterly Journal of Geological Society.
Quarterly Journal of Microscopical Science.
*Quarterly Journal of Royal Meteorological Society.
Quarterly Journal of Pure and Applied Mathematics.
Reliquary and Illustrated Archæologist.
*School of Mines Quarterly.
*Sociedad Cientifica "Antonio Alzate."
Zeitschrift für Analytische Chemie.

LIST OF MEMBERS

OF THE

PHILOSOPHICAL SOCIETY OF GLASGOW,

FOR 1896-97.

HONORARY MEMBERS.

(Limited to Twenty.)

WITH YEAR OF ELECTION.

FOREIGN.

Rudolph Albert von Kölliker, Würtzburg. 1860
Ernst Heinrich Hæckel, Jena. 1880
Georg Quincke, Heidelberg. 1890

AMERICAN AND COLONIAL.

Robert Lewis John Ellery, F.R.A.S., Victoria, Australia. 1874
5 Sir John William Dawson, LL.D., F.R.S., Principal of M'Gill College, Montreal. 1883
Thomas Muir, M.A., LL.D., F.R.S.E., Superintendent General of Education, Cape Colony. 1892
Professor S. P. Langley, LL.D., D.C.L., Secretary of the Smithsonian Institution, Washington, U.S.A. 1895

BRITISH.

Sir Joseph Dalton Hooker, K.C.B., K.C.S.I., M.D., D.C.L., LL.D., F.R.S., The Camp, Sunningdale. 1874
Herbert Spencer, care of Messrs. Williams & Norgate, 14 Henrietta street, Covent Garden, London. 1879
10 Rev. John Kerr, LL.D., F.R.S., Glasgow. 1885
Sir George Gabriel Stokes, Bart., M.A., LL.D., D.C.L., F.R.S., Lensfield cottage, Cambridge. 1887
F. Max Müller, M.A., Professor of Comparative Philology, University of Oxford, Norham gardens, Oxford. 1889
The Right Hon. Lord Rayleigh, M.A., D.C.L., LL.D., *Sec.*R.S., London, Terling place, Witham, Essex. 1890
The Right Hon. Lord Lister, LL.D., D.C.L., *P.*R.S., 12 Park crescent, Portland place, London, W. 1895
15 Sir Archibald Geikie, LL.D., D.Sc., F.R.S., F.R.S.E., F.G.S., Director-General of the Geological Survey of the United Kingdom, 10 Chester terrace, Regent's Park, London, N.W. 1895
The Right Hon. Lord Kelvin, G.C.V.O., LL.D., D.C.L., F.R.S., Professor of Natural Philosophy, University of Glasgow. 1896

CORRESPONDING MEMBERS.

WITH YEAR OF ELECTION.

A. S. Herschel, M.A., D.C.L., F.R.S., F.R.A.S.. Hon. Professor of Experimental Physics in the Durham College of Science, Newcastle-on-Tyne; Observatory House, Slough, Bucks. 1874
Thomas E. Thorpe, Ph.D., F.R.S., Professor of Chemistry in Royal College of Science, London. 1874
John Aitken, F.R.S., F.R.S.E., Ardenlea, Falkirk. 1883
Alex. Buchan, M.A., LL.D., F.R.S.E., Secretary to the Scottish Meteorological Society, 122 George street, Edinburgh. 1883
5 James Dewar, M.A., F.R.S., F.R.S.E., M.R.I., Jacksonian Professor of Physics, University of Cambridge, and Professor of Chemistry in the Royal Institution of Great Britain, 1 Scroope terrace, Cambridge. 1883
Stevenson Macadam, Ph.D., F.R.S.E., Lecturer on Chemistry, Surgeons' Hall, Edinburgh. 1883
Joseph W. Swan, M.A., F.R.S., Lauriston, Bromley, Kent. 1883
William Milne, M.A., B.Sc., F.R.S.E., Department of Public Education, Cradock, Cape Colony. 1894

ORDINARY MEMBERS.

WITH YEAR OF ENTRY.

* *Denotes Life Members.*

Adam, Stephen, 199 Bath street. 1896
*Adam, Thomas, 27 Union street. 1892
Adam, William, M.A., 235 Bath st. 1876
Adams, William, Makerstoun, Bearsden. 1891
5 Addison, W. H., Superintendent, Deaf and Dumb Institution. 1895
*Agar, Thomas F., Argentine Consul-General, 7 Royal Bank place. 1896
Aikman, C. M., M.A., D.Sc., F.R.S.E., F.I.C., F.C.S., 128 Wellington street. 1886
Alexander, D. M., Marionville, Queen's drive. 1887
Alexander, G. W., M.A., 129 Bath street. 1893
10 Alston, J. Carfrae, 27 James Watt street. 1887
Anderson, Alexander, 157 Trongate. 1869
Anderson, James, 168 George street. 1890
Anderson, John, 22 Ann street. 1884
Anderson, J. B. Mackenzie, M.B., 42 Lansdowne crescent. 1895
15 Anderson, Robert, 44 Albert drive, Crosshill. 1887
Anderson, Robert, 76 Bath street. 1896
Anderson, R. T. R., 618 Gallowgate street. 1889
*Anderson, T. M'Call, M.D., Professor of Clinical Medicine in the University of Glasgow, 2 Woodside terrace. 1873
*Anderson, William, 284 Buchanan st. 1890
20 Anderson, W. F. G., 47 Union street. 1878
*Annan, J. Craig, 234 Sauchiehall st. 1888
Annandale, Charles, M.A., LL.D., 35 Queen Mary avenue. 1888
Arnot, James Craig, 162 St. Vincent street. 1869
*Arnot, J. L., 116 West Campbell st. 1890
25 Arnot, William, City Chambers. 1894
Atkinson, J. B., 10 Foremount terrace, Partick. 1889

Bain, Andrew, 17 Athole gardens. 1890
Bain, Sir James, F.R.S.E., 3 Park terrace. 1866
Bain, Robert, 132 West Nile street. 1869
30 *Baird, J. G. A., M.P., Wellwood, Muirkirk. 1892
Ballantine, George, jun., 100 Union street. 1897
Balloch, Robert, Eamont lodge, Dowanhill. 1843
Balmain, Thos., 1 Kew terrace, Kelvinside. 1881
Barclay, A. J. Gunion, M.A., F.R.S.E., High School. 1893
35 Barclay, A. P., 133 St. Vincent street. 1890
Barclay, George, 6 Colebrooke ter. 1891
Barclay, James, 36 Windsor terrace. 1871
Barr, Archibald, D.Sc., Professor of Civil Engineering and Mechanics in the University of Glasgow, Royston, Dowanhill. 1890
*Barr, James, C.E., I.M., F.S.I., 221 West George street. 1883
40 Barr, Thos., M.D., F.F.P.S.G., 13 Woodside place, W. 1879
Barrett, Francis Thornton, Mitchell Library, *Vice-President.* 1880
Bathgate, William, M.A., 13 Westbourne gardens. 1887

Bayne, A. Malloch, 13 Kelvin drive, Kelvinside. 1878
Beatson, George T., B.A. (Cantab.), M.D., 7 Woodside crescent. 1881
45 Becker, L., Ph.D., Professor of Astronomy in the University of Glasgow, The Observatory. 1895
Begg, Wm., 636 Springfield road. 1883
Beilby, George T., F.I.C., St. Kitts, Slateford. 1895
*Beith, Gilbert, 15 Belhaven terrace. 1881
Bell, Dugald, F.G.S., 27 Lansdowne crescent. 1871
50*Bell, Henry, 39 Fitzjohn's avenue, Hampstead, London, N.W. 1876
Bell, Sir James, Bart., 101 St. Vincent street. 1877
*Bell, James T., Northcote, Dowanhill. 1896
*Bell, John J., Northcote, Dowanhill. 1896
Bennett, Robert J., Alloway park, Ayr. 1883
55 Bergius, Walter, C.E., 77 Queen street. 1897
Biles, J. H., Professor of Naval Architecture and Marine Engineering, University of Glasgow. 1893
Bilsland, William, 28 Park circus. 1888
*Bishop, A. Henderson, 32 Herbert street. 1896
Black, D. Campbell, M.D., M.R.C.S.E., Professor of Physiology, Anderson's College Medical School, 121 Douglas street. 1872
60 Black, J. Albert, Duneira, Row. 1869
Black, Malcolm, M.D., 5 Canning place. 1880
*Blackie, J. Alexander, 17 Stanhope street. 1881
*Blackie, J. Robertson, 17 Stanhope street. 1881
Blackie, W. G., Ph.D., LL.D., F.R.G.S., 1 Belhaven terrace, Kelvinside. 1841
65*Blackie, Walter W., B.Sc., 17 Stanhope street. 1886
Blair, G. M'Lellan, 2 Lilybank terrace. 1869
Blair, J. M'Lellan, Williamcraig, Linlithgowshire. 1869
Blair, Matthew, 5 Hampton Court terrace. 1887
Blyth, James, M.A., F.R.S.E., Professor of Natural Philosophy, Glasgow and West of Scotland Technical College, 204 George street. 1881
70*Blyth, Robert, 1 Montgomerie quadrant. 1885
*Blythswood, The Rt. Hon. Lord, Renfrew. 1885
*Borland, William, 142 St. Vincent st. 1895
Borthwick, James D., 46 Balshagray avenue, Partick. 1891
Bottomley, James T., M.A., D.Sc., F.R.S., F.R.S.E., F.C.S., Demonstrator in Natural Philosophy, University of Glasgow, 13 University gardens, Hillhead. 1880
75 Bottomley, Wm., C.E., 15 University gardens. 1880
Bower, F. O., D.Sc., M.A., F.R.S., F.L.S., Regius Professor of Botany in the University of Glasgow, 45 Kersland terrace. 1885
Boyd, John, Shettleston Iron-works, near Glasgow. 1873
Brier, Henry, M.I.M E., 13 Ailsa drive, Langside. 1889
Brodie, John Ewan, M.D., C.M., F.F.P.S.G., 5 Woodside place. 1873
80 Brown, Alexander, 3 Queen's terrace. 1887
Brown, Alex., The Craigs, Carmunnock. 1896
*Brown, Hugh, 5 St. John's terrace, Hillhead. 1887
Brown, James, 76 St. Vincent st. 1876
*Brown, John, 11 Somerset place. 1881
85 Brown, Richard, 138 W. George street. 1895
Brown, Robert, 19 Jamaica street. 1882
*Brown, Wm. Stevenson, 41 Oswald street. 1886
*Brown, William, 165 W. George st. 1892
Browne, Richard, Beechholm, Queen's drive, Crosshill. 1893
90 Browne, Robert, B.Sc., 45 Washington street. 1893
Brownlie, Archibald, Bank of Scotland, Barrhead. 1880
Brownlie, J. Rankin, L.D.S.(Eng.), 220 West George street. 1892
Bruce, David, M.A., LL.B., Writer, 49 West George street. 1897
*Bryce, Robert, 82 Oswald street. 1886
95 Buchan, David W., Fairy Knowe, Cambuslang. 1896
Buchanan, Alex. M., A.M., M.D., Professor of Anatomy, Anderson's College Medical School, 98 St. George's road. 1876
Buchanan, George S., 85 Candleriggs. 1845
*Buchanan, Wm., Enderley, Bearsden. 1886
Burnet, John, F.R.I.B.A., I.A., 167 St. Vincent street. 1850
100 Burnet, John James, A.R.S.A., F.R.I.B.A., 18 University avenue. 1892
Burns, J., M.D., 15 Fitzroy place, Sauchiehall street. 1864
Burton, Thomas John, M.D.(Ed.), Lonsdale, Bearsden. 1896

*Caldwell, George B., Scotia Leather Works, Boden street. 1892
Cameron, Sir Charles, Bart., M.D., LL.D., Greenock. 1870
105 Cameron, H. C., M.D., 200 Bath street. 1873
*Campbell, Archibald, Springfield quay. 1895
*Campbell, J. A., LL.D., M.P., Stracathro, Brechin. 1848
*Campbell, James, 137 Ingram st. 1885
*Campbell, John Ferguson, 2 Holborn terrace, N., Kelvinside. 1892
110 Campbell, John MacNaught, C.E., F.Z.S., F.R.S.G.S., Kelvingrove Museum. 1883
Campbell, Malcolm, 18 Gordon st. 1894
*Campbell, Thomas, Maryhill Ironworks. 1894
Carlile, Thomas, Gogar park, Corstorphine, Midlothian. 1851
Carlile, William W., Hailie, Largs, Ayrshire. 1897
115 Carmichael, Neil, M.D., C.M., F. F. P. S. G., Invercarmel, 23 Nithsdale drive, Pollokshields. 1873
Carver, Thomas, A.B., B.Sc., C.E., Heigham, Aubrey road, Hornsey, London, N. 1890
Cassells, John, 62 Glencairn drive, Pollokshields. 1890
Cassells, Robert Dunlop, B.Sc., 62 Glencairn drive, Pollokshields. 1895
*Cayzer, Sir Charles W., M.P., 109 Hope street. 1886
120 Chalmers, A. K., M.D., D.P.H. (Camb.), 23 Kersland terrace. 1892
Chalmers, George, 13 Hamilton crescent, Partickhill. 1896
Chalmers, James, I.A., 93 Hope street. 1884
Chalmers, P. MacGregor, I. A., F.S.A.Scot., 95 Bath street. 1891
Cherrie, James M., Clutha cottage, Tollcross. 1876
125 *Chisholm, Samuel, 4 Royal ter., W. 1890
*Christie, Henry W., Levenfield house, Alexandria. 1892
Christie, John, Turkey-red Works, Alexandria, Dumbartonshire. 1868
Chrystal, W. J., F.I.C., F.C.S., Shawfield Works, Rutherglen. 1882
Clark, John, Ph.D., F.I.C., F.C.S., 138 Bath street. 1870
130 Clark, John, 9 Wilton crescent. 1872
*Clark, William, 125 Buchanan st. 1876
*Cleland, John, M.D., LL.D., D.Sc., F.R.S., Professor of Anatomy in the University of Glasgow. 1884
*Coats, Joseph, M.D., Professor of Pathology in the University of Glasgow, 8 University gardens. 1873
*Cochran, Robert, 7 Crown circus, Dowanhill. 1877
135 Coghill, Wm. C., 263 Argyle street. 1873
*Colquhoun, James, LL.D., 158 St. Vincent street. 1876
Colville, James, M.A., D.Sc., 14 Newton place. 1885
Combe, James Russell, 257 West Campbell street. 1895
Connell, William, 44 St. Enoch square. 1870
140 Connell, William, jun., Coldstream, Cathkin road, Langside. 1897
Cooke, Louis H., A.R.S.M., Royal School of Mines, London. 1893
Copland, Wm. R., M.Inst.C.E., F.S.I., 146 West Regent street. 1876
Core, Wm., M.D., Medical Superintendent, Barnhill Hospital. 1891
Coste, Jules, French Consulate, 131 West Regent street. 1888
145 Costigane, John T., Limekilns house, East Kilbride. 1889
Costigane, William, Clifton hall, Albert drive, Pollokshields. 1890
Coubrough, A. Sykes, Parklea, Blanefield, Strathblane. 1869
Coulson, W. Arthur, 47 King street, Mile-end. 1888
Couper, James, Craigforth house, Stirling. 1862
150 Couper, Sinclair, Moore Park Works, Helen street, Govan. 1896
Cowan, M'Taggart, C.E., 53 Ashton terrace, Hillhead. 1876
Craig, T. A., C.A., 139 St. Vincent street. 1886
Crawford, Wm. C., M.A., Lockharton gardens, Colinton road, Edinburgh. 1869
Cree, Thomas S., 21 Exchange sq. 1869
155 Crichton, James, 201 Nithsdale road, Pollokshields. 1892
Crosbie, L. Talbot, Scotstounhill, Whiteinch. 1890
Cross, Alexander, M.P., 14 Woodlands terrace. 1887
Crosskey, Lewes R., 34 Wilton gardens. 1896
*Crum, Walter G., Thornliebank. 1895
160 Crum, William G., Thornliebank. 1896
Curphey, Wm. Salvador, 15 Bute mansions, Hillhead. 1883
Cuthbert, Alexander A., 14 Newton terrace. 1885
Cuthbertson, Sir John N., LL.D., 29 Bath street. 1850
Cuthbertson, Thomas W., M.A., 25 Blythswood square. 1897

165 Dalziel, J. Kennedy, M.B., C.M., 196 Bath street. 1896

*Dansken, A. B., 105 West George street. 1877
*Dansken, John, I.M., F.S.I., F.R.A.S., 241 West George street. 1876
Darling, Geo. E., 178 St. Vincent street. 1870
Davey, Arthur J., London Road Iron-works. 1895
170 Deas, Jas., C.E., 7 Crown gardens, Dowanhill. 1869
Dempster, John, 4 Belmar terrace, Pollokshields. 1875
Dennison, William, C.E., 175 Hope street. 1876
*Dick, George Handasyde, 136 Buchanan street. 1887
*Dixon, A. Dow, 10 Montgomerie crescent, Kelvinside. 1873
175 Dixon, Walter, 164 St. Vincent st. 1893
Dobbie, A. B., M.A., University. 1885
Dobson, James, Springfield avenue, Uddingston. 1892
Donald, John, Townhead Public School. 1872
Donald, William J. A., 70 Great Clyde street. 1877
180 Dougall, Franc Gibb, 167 Canning street. 1875
Douglas, Campbell, I.A., F.R.I.B.A., 266 St. Vincent street. 1870
Dowie, George, 50 West Campbell street. 1896
Downie, Robert, jun., Carntyne Dye-works, Parkhead. 1872
Downie, Thomas, Hydepark Foundry. 1886
185*Dreghorn, David, Smith st., Kinning Park. 1896
*Duncan, Eben., M.D., C.M., F.F.P.S.G., Queen's Park house, Langside road, *President.* 1873
Duncan, Hugh, M.A., LL.B., 175 West George street. 1895
Duncan, J. A., Glenlee, Bridge of Allan. 1896
*Duncan, Robert, Whitefield Works, Govan. 1890
190*Duncan, Walter, 137 West George street. 1881
*Dunlop, Nathaniel, 25 Bothwell st. 1870
Dunn, Robert Hunter, 4 Belmont crescent. 1878
Dyer, Henry, M.A., D.Sc., C.E., 8 Highburgh terrace, Dowanhill. 1883

Edington, George Henry, M.D., M.R.C.S.(Eng.), 14 Buckingham terrace. 1896
195*Edwards, John, Govanhaugh Dye-works, M'Neil street. 1883
Elgar, Francis, LL.D., F.R.S., 113 Cannon street, London, E.C. 1884
Elliot, G. F. Scott, M.A., B.Sc., F.L.S., F.R.G.S., 1 Wilton mansions, Kelvinside, North. 1896
*Ellis, T. Leonard, North British Iron-works, Coatbridge. 1888
Erskine, Jas., M.A., M.B., L.F.P.S.G., 351 Bath street. 1886
200*Ewing, Wm., 45 Renfield street. 1883

Fairweather, Wallace, C.E., 62 St. Vincent street. 1880
Falconer, Patrick, 19 Kelvinside gardens. 1876
Falconer, Thos., 50 Kelvingrove st. 1880
Farquhar, John, 13 Belhaven terrace. 1872
205 Farquhar, Wm. R., Marymar, Kilmalcolm. 1892
Fawsitt, Charles A., 9 Foremount terrace, Partick. 1879
*Fergus, Freeland, M.D., F.F.P.S.G., *Hon. Secretary*, 203 Bath street. 1887
*Fergus, Oswald, D.D.S., L.D.S., 27 Blythswood square. 1896
*Ferguson, John, M.A., LL.D., F.R.S.E., Professor of Chemistry, University of Glasgow, *Hon. Vice-President.* 1869
210 Ferguson, John Forbes, 138 West George street. 1895
Ferguson, Peter, 15 Bute gardens, Hillhead. 1866
Fergusson, Alex. A., 48 M'Alpine street. 1847
Findlay, Joseph, Clairmont, Winton drive, Kelvinside. 1873
Finlayson, James, M.D., 2 Woodside place. 1873
215*Fleming, James, 136 Glebe street. 1880
*Fleming, William James, M.D., 3 Woodside terrace. 1876
Fotheringham, T. B., 65 West Regent street. 1889
Foulis, William, C.E., 45 John street. 1870
*Fowler, John, 5 Derby street, Sandyford. 1880
220 Frame, James, Union Bank of Scotland, 1 Maxwelton place, Paisley road. 1885
Fraser, Melville, 31 St. Vincent place. 1890
Frew, Alex., C.E., 175 Hope street. 1876
*Fullerton, Robt., M.D., 24 Newton place. 1896
Fulton, R. C., 14 Hamilton Park terrace. 1890
225 Fyfe, Henry B., 115 St. Vincent street. 1892
Gairdner, Charles, LL.D., Broom, Newton-Mearns. 1884
*Gairdner, C. D., C.A., 115 St. Vincent street. 1886

Gairdner, W. T., M.D., LL.D., F.R.S., Professor of Practice of Medicine in the University of Glasgow, 225 St. Vincent street. 1863
Galbraith, Peter, 17 Huntly gardens. 1889
230 Galbraith, Walter M., 7 Holyrood crescent. 1893
Gale, James M., C.E., 45 John st. 1856
Galloway, T. Lindsay, C.E., 43 Mair street, Plantation. 1881
Gardner, Daniel, 36 Jamaica street. 1869
*Garrow, James R., 6 Pollok road. 1890
235*Garroway, John, 694 Duke st. 1875
Gibson, Charles R., St. Mirren's Mills, Paisley. 1895
Gibson, William, 2 Wilton mansions. 1896
Gilfillan, Wm., 129 St. Vincent st. 1881
Gillies, W. D., 17 Royal Exchange square. 1872
240 Gilmour, William D., 8 Albion place, Byars Road. 1896
Glaister, John, M.D., F.F.P.S.G., D.P.H.(Camb.), &c., Professor of Medical Jurisprudence and Public Health, St. Mungo's College, 4 Grafton place. 1879
Goldie, James, 52 St. Enoch square. 1883
Goodwin, Robert, 58 Renfield street. 1875
Gourlay, John, C.A., 24 George square. 1874
245 Gow, Leonard, 45 Renfield street. 1889
Gow, Leonard, jun., 45 Renfield street. 1884
Gow, Robert, 3 Victoria circus, Dowanhill gardens. 1860
Graham, Alex. M., Rowanlea, 7 St. Andrew's drive, Pollokshields. 1887
*Graham, Robert, 108 Eglinton st. 1888
250*Graham, William, B.L., 11 Claremont terrace. 1885
Gray, Andrew, 30 Bath street. 1889
Gray, James, M.D., 15 Newton terrace. 1863
Greig, James R., Claremont, Langside. 1897

Halket, George, M.D., F.F.P.S.G., 4 Royal crescent, W. 1889
255 Hamilton, Don., Brandon, Uddingston. 1894
*Hamilton, John, I.A., 212 St. Vincent street. 1885
Harley, George, 29 Burnbank gardens. 1891
Harvey, William Ure, 56 Robertson street. 1896
*Harvie, John, Secretary, Clydesdale Bank, 30 St. Vincent place. 1880
260 Harvie, William, 8 Bothwell terrace, Hillhead. 1888

Hassard, William John, 209 Sauchiehall street. 1895
Hedderwick, Maxwell, 22 St. Vincent place. 1892
Henderson, Alex., Barnhill Poorhouse. 1894
*Henderson, A. P., 20 Newton place. 1880
265 Henderson, George G., M.A., D.Sc., F.I.C., F.C.S., Professor of Chemistry, Glasgow and West of Scotland Technical College, 204 George street. 1883
Henderson, John, 38 Berkeley st. 1893
*Henderson, John, Meadowside Works, Partick. 1879
Henderson, John, Towerville, Helensburgh. 1890
Henderson, Robert, 167 West Regent street. 1885
270*Henderson, William, 15 Cadogan street. 1873
Hendrick, James, B.Sc., F.C.S., 60 John street. 1893
Hendry, George Scott, 87 Bothwell street. 1895
Henry, R. W., 62 Kelvingrove st. 1875
Heys, Zechariah J., South Arthurlie, Barrhead. 1870
275 Higgins, Henry, jun., 248 West George street. 1878
Hinshelwood, James, M.A., M.D., 9 Elmbank street. 1896
Hodge, William, 27 Montgomerie drive, Kelvinside. 1878
Hogg, Robert, 9 Nithsdale drive, Pollokshields. 1865
Horton, William, Birchfield, Mount Florida. 1889
280 Houstoun, Wm. Henry, Hillcrest, Cambridge drive. 1895
Howat, William, 37 Elliot street. 1885
Howatt, Wm., I.M., 146 Buchanan street. 1870
Hunt, Edmund, 121 West George street. 1856
*Hunt, John, Milton of Campsie. 1881
285*Hunter, Wm. S., 30 Hope street. 1889
Hutchison, Peter, 3 Lilybank terrace, Hillhead. 1889

Inglis, John, Pointhouse Shipyard. 1895
Inglis, R. A., Culrain, Bothwell. 1889

*Jack, William, M.A., LL.D., Professor of Mathematics in the University of Glasgow. 1881
290 Jamieson, Andrew, F.R.S.E., M.Inst.C.E., M.Inst.E.E., &c., Professor of Electrical Engineering, Glasgow and West of Scotland Technical College, 16 Rosslyn terrace, Kelvinside. 1881

Jenkins, Thomas Wilson, M.A., M.D., 1 Newark drive. 1892
Johnston, David, 160 West George st. 1891
Johnston, George, Mosesfield, Springburn. 1896
Johnstone, Jas., Coatbridge street, Port-Dundas. 1869

5 Kay, Wm. E., F.C.S., 47 Camphill street, Crosshill. 1887
Kean, James, 32 Scotia street, Garnethill. 1888
Kelly, James K., M.D., F.F.P.S.G., Park villa, Queen Mary avenue, Crosshill. 1889
Kennedy, James, 33 Greendyke street. 1889
Ker, Charles, M.A., C.A., 115 St. Vincent street. 1885
00 *Ker, Wm., 1 Windsor terrace, West. 1874
Kerr, Adam, 175 Trongate. 1887
Kerr, Charles James, 40 West Nile street. 1877
Kerr, Geo. Munro, 97 Buchanan street. 1890
Kerr, John G., M.A., 15 India street. 1878
05 Key, William, 109 Hope street. 1877
King, James, 57 Hamilton drive, Hillhead. 1848
King, Sir James, Bart., LL.D., of Campsie, 115 Wellington street. 1855
King, John, Tigh Ruadh, Possilpark. 1895
King, John Y., 142 St. Vincent street. 1893
10 Kirk, Robert, M.D., Newton cottage, Partick. 1877
Kirkpatrick, Alexander B., 88 St. Vincent street. 1885
Kirkpatrick, Andrew J., 179 West George street. 1869
Kirkwood, James, Carling lodge, Ibrox. 1890
Knight, James, M.A., B.Sc., F.C.S., F.G.S., The Shieling, Uddingston. 1893
15 *Knox, David J., 19 Renfield street. 1890
Knox, John, 41 Mid Wharf, Port-Dundas. 1883

Laird, George H., 3 Seton terrace, Dennistoun. 1882
Laird, John, Marchmont, Port-Glasgow. 1876
Laird, John, Royal Exchange Sale Rooms. 1879
20 Lamb, David, 3 Albion place, Dowanhill. 1896
Lamond, Robert, 8 Marchmount terrace, Kelvinside. 1894
Lang, William, F.C.S., Crosspark, Partick. 1865
*Lauder, James, F.R.S.L., Glasgow Athenæum. 1892
Lauder, John, 87 Union street. 1894
325 Law, John R. K., 20 Ashton gardens, Dowanhill.
Leitch, Alexander, 60 Rosebank terrace, Grant street. 1886
Leslie, John A., jun., 48 Cadogan street. 1894
*Lindsay, Archd. M., M.A., 87 West Regent street. 1872
Lodge, Richard, M.A., Professor of History, University of Glasgow. 1895
330 Lothian, Alex. V., M.A., 11 Holborn terrace. 1893
Love, James Kerr, M.D., C.M., 10 Newark drive. 1888
Lundholm, C. O., Nobel's Explosives Factory, Ardeer, Stevenston. 1890

M'Ara, Alexander, 65 Morrison street 1888
M'Arly, Thomas, 29 West George street. 1897
335 MacArthur, J. G., Rosemary villa, Bowling. 1874
*MacArthur, John S., 108A Hope street. 1890
M'Bain, W. C., 75 Jamaica street. 1895
M'Callum, Robert, jun., 69 Union street. 1891
*M'Clelland, Andrew Simpson, C.A., 4 Crown gardens, Dowanhill. 1884
340 M'Conville, John, M.D., 27 Newton place. 1870
M'Cracken, James, 5 Bowmont terrace, Kelvinside. 1889
M'Crae, John, 7 Kirklee gardens, Kelvinside. 1876
M'Creath, James, M.E., 208 St. Vincent street. 1874
M'Culloch, Hugh, 154 West Regent street. 1880
345 Macdonald, Archibald G., 8 Park circus. 1869
M'Donald, David, 11 Huntly gardens, Kelvinside. 1897
*Macdonald, John, 72 Great Clyde street. 1896
Macdonald, Thomas, 50 Gibson street, Hillhead. 1869
*Macfarlane, Walter, 12 Lynedoch crescent. 1885
350 M'Farlane, Wm., Edina lodge, Rutherglen. 1888
*M'Gilvray, R. A., 129 West Regent street. 1880
M'Gregor, Duncan, F.R.G.S., 37 Clyde place. 1867

M'Houl, David, Ph.D., Dalquhurn Works, Renton. 1883
*Macindoe, Alex., C.A., 104 West George street 1894
355 Macintosh, Donald J., M.B., C.M., Western Infirmary. 1894
Macintyre, John, M.B., C.M., 179 Bath street. 1895
M'Intyre, Wm., Marion bank, Rutherglen. 1888
M'Kellar, John C., 112 Bath st. 1896
M'Kellar, J., 25 Kelvinside terrace. 1893
360*M'Kendrick, John G., M.D., C.M., LL.D., F.R.S., F.R.S.E., F.R.C.P.E., Professor of Institutes of Medicine in the University of Glasgow, 2 Florentine gardens, *Hon. Vice-President.* 1877
*M'Kenzie, W. D., 43 Howard street. 1875
*M'Kenzie, W. J., 24 Wilton gardens, North, Kelvinside. 1879
Mackinlay, David, 6 Great Western terrace, Hillhead. 1855
*Mackinlay, James Murray, 4 Westbourne gardens. 1886
365 M'Kissack, John, 68 West Regent street. 1881
Maclae, A. Crum, 147 St. Vincent street. 1884
M'Laurin, Robert, 303 Main street, Maryhill. 1895
*Maclay, David T., 169 W. George street. 1879
Maclay, W., Eildon villas, Mount Florida. 1893
370 Maclean, A. H., 8 Hughenden terrace, Kelvinside. 1870
Maclean, Magnus, M.A., F.R.S.E., D.Sc., 8 St. Albans ter, Hillhead. 1885
MacLehose, James J., M.A., 61 St. Vincent street. 1882
*Macleod, A., 3 Dundas street. 1893
M'Lennan, James, 40 St. Andrew's street. 1888
375 Macnair, D. S., Ph.D., B.Sc., Glenogle, Kilmalcolm. 1895
Macouat, R. B., 37 Elliot street 1885
Macphail, Donald, M.D., Garturk cottage, Whifflet, Coatbridge. 1877
M'Pherson, George L., 30 Albert road, Crosshill, East. 1872
M'Vail, D. C., M.B., Professor of Clinical Medicine, St. Mungo's College, 3 St. James' terrace, Hillhead. 1873
380 Machell, Thomas, 1 Burnbank terrace, 1886
Main, Robert B., 56 Dalziel drive. 1885
Malloch, A. M., Firhill, Garscube road. 1896
Mann, John, C.A., 137 West George street, *Treasurer.* 1856
Mann, John, jun., M.A., C.A., 137 West George street. 1885
385 Manwell, James, The Hut, 4 Albert drive, Pollokshields. 1876
Marshall, T. Rhymer, D.Sc., Professor of Chemistry in St. Mungo's College, 19 Sandyford place. 1894
Martin, Jas. F., 63 Brunswick street. 1895
Martin, William, 116 St. Vincent street. 1892
Marwick, Sir J. D., LL.D., F.R.S.E., 19 Woodside terrace. 1878
390 Mathie, George M., 15 Wardlawhill terrace, Rutherglen. 1895
Mathieson, J. H., 3 Grosvenor ter., Kelvinside. 1896
Mathieson, T. O., 3 Grosvenor ter. 1896
Mavor, Henry A., 47 King street, Mile-end. 1887
Mavor, James, The University, Toronto, Canada. 1885
395 Mavor, Samuel, 3 Elmbank cres. 1890
Mayer, John, Strathview, Cathkin road, Langside, *Acting Secretary.* 1860
Mechan, Arthur, 60 Elliot street. 1876
Mechan, Henry, 60 Elliot street. 1879
Meikle, Andrew W., M.A., Viewfield house, Pollokshields. 1890
400 Menzies, Thos., Hutchesons' Grammar School, Crown street. 1859
*Menzies, Thos. J., M.A., B.Sc., F.C.S., 211 Crown street, S.S. 1887
Menzies, William Crawford, City Improvement Trust, 34 Trongate. 1895
Millar, James, 158 Parliamentary road. 1870
Miller, A. Lindsay, 122 Wellington street. 1878
405*Miller, Arch. Russell, Castlebank, Bothwell. 1884
Miller, Major David S., 8 Royal crescent, W. 1887
*Miller, George, Winton drive, Kelvinside. 1881
Miller, G. J., Frankfield, Shettleston. 1888
Miller, John (Messrs. James Black & Co.), 23 Royal Exchange square. 1874
410 Miller, Richard, 6 Dixon street. 1885
*Miller, Thos. P., Cambuslang Dyeworks. 1864
Milligan, Thomas R., 22 Arlington street. 1892
Mills, Edmund J., D.Sc., F.R.S., "Young" Professor of Technical Chemistry, Glasgow and West of Scotland Technical College, 60 John street. 1875
Mirrlees, James B., Redlands, Kelvinside. 1869

415*Mirrlees, William J., 45 Scotland st. 1889
Mitchell, Andrew, C.A., 187 West George street. 1896
*Mitchell, George A., 5 West Regent street. 1883
Mitchell, Robert, 12 Wilson street, Hillhead. 1870
*Moffatt, Alexander, 23 Abercromby place, Edinburgh. 1874
420 Mollison, James, 6 Hillside gardens, Partick. 1889
*Mond, Robert Ludwig, B.A. (Cantab), F.R.S.E., 20 Avenue road, Regent's park, London, N.W. 1890
*Monteith, Robert, Greenbank, Dowanhill gardens. 1885
Moore, Alexander, C.A., 209 West George street. 1869
Moore, Alexander George, M.A., B.Sc., 13 Clairmont gardens. 1886
425 Morrice, Jas. A., 1 Prince's ter., Dowanhill. 1883
Motion, James Russell, 38 Cochrane street. 1887
Muir, Alex., 400 Eglinton street. 1883
*Muir, Allan, Ardmay, Newlands road, Langside. 1881
Muir, James, C.A., 149 West George street. 1887
430 Muir, Sir John, Bart., 22 West Nile street. 1876
*Muirhead, Andrew Erskine, Cart Forge, Crossmyloof. 1873
Muirhead, James, 2 Bowmont gardens, Kelvinside. 1887
*Muirhead, Robert F., M.A., B.Sc., 14 Kersland street, Hillhead. 1879
Munro, Daniel, F.S.I., 10 Doune terrace, Kelvinside. 1867
435 Munro, J. M. M., M. Inst. E. E., M.Inst.C.E., F.R.S.E., 136 Bothwell street. 1896
Munsie, George, 1 St. John's ter., Hillhead. 1871
Munsie, Robert George, 10 Berkeley terrace, West. 1883
Murdoch, George, 40 St. Vincent pl. 1894
*Murdoch, Robert, 91 Maxwell road. 1880
440*Murray, Daniel, 4 Eastpark terrace, Maryhill. 1896
*Murray, David, LL.D., 169 West George street. 1876
Murray, John Bruce, 12 Mitchell street. 1890
Murrie, James, 264 St. Vincent st. 1892

Napier, Alex., M.D., F.F.P.S.G., Rose Bank, Queen Mary avenue, Crosshill. 1886
445 Napier, James, 15 Prince's square, Strathbungo. 1870
*Napier, John, Audley mansions, Grosvenor square, London. 1849
*Neilson, James, 116 Bishop street, Port-Dundas. 1896
Nelson, Alex., 80 Gordon street. 1880
*Newlands, Joseph F., 28 Renfield st. 1883

450 Orr, Robert, 79 West Nile street. 1890
Osborne, Alex., 4 Kew terrace. 1870
Osborne, Robert, 4 Huntly gardens. 1890

Park, James, 51 Millburn street. 1877
Park, Robert, M.D., 40 Grant st. 1894
455 Parker, Edward H., 207 Bath st. 1897
*Parker, John Dunlop, C.E., 146 West Regent street. 1889
*Parnie, James, F.S.I., 32 Lynedoch street. 1874
*Paterson, Robert, C.A., 28 Renfield street. 1881
Paton, James, F.L.S., Corporation Galleries, and Kelvingrove Museum. 1876
460 Patrick, Joseph, M.A., C.A., 203 West George street. 1893
Patterson, T. L., F.C.S., Maybank, Finnart street, Greenock. 1873
Paul, F. W., Mount Vernon. 1896
Petrie, Alexander, I.A., 134 Wellington street. 1885
Pirie, John, M.D., 26 Elmbank crescent. 1877
465*Pirrie, Robert, 9 Buckingham ter. 1875
*Pollock, R., M.B., C.M., F.F.P.S.G., Laurieston house, Pollokshields. 1883
Prince, Edward E., B.A. (Cantab), F.L.S., Ottawa, Canada. 1892
Pringle, Patrick James, 115 Mains street. 1892
*Provan, James, 40 West Nile st. 1868
470 Provand, A. D., M.P., 2 Whitehill court, London, S.W. 1888

Raalte, Jacques Van, 105 West George street. 1884
Ramsey, Robert, 14 Park terrace. 1889
Rankine, David, C.E., 238 West George street. 1875
Rattray, Rev. Alex., M.A., Parkhead Parish, 4 Westercraigs, Dennistoun. 1879
475 Rattray, William A., 233 Hope st. 1890
Reid, David, 16 Cambridge street. 1887
*Reid, Hugh, Belmont, Springburn. 1880
Reid, James, 15 Montgomerie cres. 1886
Reid, Thos., M.D., LL.D., 11 Elmbank street. 1869
480 Reid, William, M.A., 61 Grant st. 1881
*Reid, William L., M.D., Professor of Midwifery, Anderson's College Medical School, 7 Royal crescent, West. 1882

Reith, Rev. George, M.A., D.D., Free College Church, 37 Lynedoch st. 1876
Renton, James Crawford, M.D., L.R.C.P.& S.Ed., 1 Woodside ter. 1875
Rey, Hector, B.L., B.Sc., 2 Ailsa terrace. 1889
485 Richmond, Thos., L.R.C.P.E., 2 Royal crescent, West. 1887
Ritchie, George, Parkhead Forge and Steel Works. 1890
Robb, John, Busby house, Busby. 1897
Robertson, John, Woodside school, Endcliffe, Langside, *Librarian.* 1860
Robertson, J. M'Gregor, M.A., M.B., C.M., 26 Buckingham ter., Hillhead. 1881
490 Robertson, Robert A., 8 Park Circus place. 1877
Robertson, Robert H., Clyde bank, Rutherglen. 1888
Robertson, William, C.E., 123 St. Vincent street. 1869
*Rogers, John C., 224 St. Vincent st. 1888
Rose, Alexander, Richmond house, Dowanhill. 1879
495*Rose, Charles A., Belmont, Dowanhill gardens. 1889
*Ross, David, M.A., B.Sc., LL.D., E.C. Training College. 1888
Ross, Henry, 7 Park quadrant. 1876
*Ross, John, 9 Westbourne gardens. 1885
Ross, John Munn, C.A., 115 Wellington street. 1894
500 Ross, William, 10 Regent place, Shawlands. 1893
Rottenburg, Paul, 105 West George street. 1872
Rowan, David, 22 Woodside place. 1863
Rowan, W. G., 234 West George st. 1881
Rundell, R. Cooper, Underwriters' Room, Royal Exchange. 1877
505 Russell, James B., B.A., M.D., LL.D., 3 Foremount terrace, Partick, *Hon. Vice-President.* 1862

Salmon, W. Forrest, F.R.I.B.A., 197 St. Vincent street. 1870
Sawers, Wm. D., Assoc. I.C., Nundydroog Gold Mining Co., Ltd., Oorgaum, Mysore, India. 1894
Sayers, William Brooks, 189 St. Vincent street. 1890
Schmidt, Alfred, 508 New City rd. 1881
510 Sclanders, David, jun., 41 Virginia street. 1895
Scott, Alex., 34 Lawrence street, Dowanhill. 1871
*Scott, D. M'Laren, 2 Park quad. 1881
Scott, John, 142 West Regent st. 1891
Scott, John, 245 Sauchiehall st. 1892
515 Scott, Robt., I.M., 115 Wellington street. 1884

Seligmann, Hermann L., 59 St. Vincent street. 1
Sexton, A. Humboldt, F.C.S., F.I.C., F.R.S.E., Professor of Metallurgy, Glasgow and West of Scotland Technical College, 204 George street. 1
Shannan, A. M'Farlane, 7 Scott street, Garnethill. 1
Simons, Michael, 206 Bath street. 1
520 Simpson, J. C., M.D., 9 Marlborough terrace, Kelvinside. 1
Sinclair, Alexander, Ajmere lodge, Langside. 1
Sloane, F. N., C.A., 187 West George street. 1
Smart, William, M.A., LL.D., Professor of Political Economy, University of Glasgow, Nunholm, Dowanhill. 1
Smellie, George, I.M., 167 St. Vincent street. 1
525*Smellie, Thos. D., F.S.I. 209 St. Vincent street. 1
Smith, Alex. Muir, M.D., C.M., 13 Montgomerie street, North Kelvinside. 1
Smith, D. Johnstone, C.A., 149 W. George street. 1
Smith, Hugh C., 55 Bath street. 1
*Smith, J. Guthrie, 54 W. Nile st. 1
530*Smith, Robert B., Bonnybridge, Stirlingshire. 1
*Smith, W. B., 31 Queen street. 1
Snodgrass, James, F.C.S., 2 Keir terrace, Pollokshields. 1
Snodgrass, William, M.A., M.B., C.M., Muirhead Demonstrator of Physiology, University of Glasgow, 11 Victoria crescent, Dowanhill. 1
*Somerville, Alexander, B.Sc., F.L.S., 4 Bute mansions, Hillhead street, Hillhead. 1
535 Sorley, Robert, 3 Buchanan st. 1
Spencer, Charles L., Edgehill, Kelvinside. 1
Spencer, J. J., Edgehill, Kelvinside. 1
Spens, John A., 169 W. George street. 1
*Spiers, John, 493 Great Western road, Hillhead. 1
540 Stanford, Edward C. C., F.C.S., Glenwood, Dalmuir, Dumbartonshire. 1
*Steel, William Strang, Philiphaugh, Selkirk. 1
*Stephen, John, Domira, Partick. 1
Steuart, Daniel Rankin, Osborne cottage, Broxburn, West Lothian. 1
*Steven, Hugh, Westmount, Montgomerie drive. 1

545 Steven, John, 32 Elliot street. 1875
*Stevenson, D. M., 12 Waterloo street.
*Stevenson, Jas., F.R.G.S., 23 West Nile street. 1870
Stevenson, John, 12 Victoria road, Lenzie. 1892
Stevenson, Wm., 21 Clyde place. 1888
550 Stewart, Andrew, 41 Oswald street. 1887
Stewart, Archibald, Marnock villa, Queen's drive, Crosshill. 1892
Stewart, David, 3 Clifton place. 1856
Stewart, John, 220 Parliamentary road. 1896
*Stobo, Thomas, Somerset house, Garelochhead. 1884
555 Stoddart, James Edward, Howden, Mid-Calder, N.B. 1872
Strachan, R. U., Sheriff-Substitute, 9 Crown terrace. 1896
*Strain, John, C.E., 154 West George street. 1876
Strathie, David, C.A., 162 St. Vincent street. 1895
*Sutherland, David, Royal Marine Hotel, Nairn. 1880
560*Sutherland, John, Great Western Hotel, Oban. 1880
Sutherland, J. R., C.E., 45 John street. 1884
Swan, Charles C., 15 Rose street, Garnethill. 1891
Syminton, Thomas, Solicitor, 94 Hope street. 1896

Tatlock, John, F.I.C., 13 Parkgrove terrace, West, Sandyford. 1875
565 Tatlock, Robt. R., F.R.S.E., F.I.C., F.C.S., 156 Bath street. 1868
Taylor, Benjamin, F.R.G.S., 10 Derby crescent, Kelvinside. 1872
Teacher, Adam, 14 St. Enoch square. 1868
Teague, Francis, M.I.E.E., Electric Lighting Station, Paisley. 1894
Tennant, Sir Charles, Bart., 195 West George street. 1868
570 Tennent, Gavin P., M.D., 159 Bath street. 1875
Thomas, Moses, M.D., Superintendent, Royal Infirmary. 1890
Thomson, David, I.A., F.R.I.B.A., 2 West Regent street. 1869
Thomson, George C., F.C.S., 1 Thornwood terrace, Partick. 1883
Thomson, Gilbert, M.A., C.E., 97 Wellington st., *Vice-President.* 1885
575 Thomson, Graham Hardie, 2 Marlborough terrace, Kelvinside. 1869
Thompson, G. R., 204 George street. 1895
*Thomson, James, F.R.I.B.A., 88 Bath street. 1886
*Thomson, James M., Glen Tower, Kelvinside. 1892
Townsend, C. W., Crawford street, Port-Dundas. 1890
580*Tullis, David, St. Ann's Leather Works, Bridgeton. 1894
*Tullis, James Thomson, Anchorage, Burnside, Rutherglen. 1883
*Turnbull, John, jun., M.I.M.E., 18 Blythswood square. 1883
Turnbull, Robert, 122 Wellington street. 1895
Turner, George A., M.D., 1 Clifton place, Sauchiehall street. 1883
585 Turner, William, Rachen house, Helensburgh. 1875
Turpie, John, 339 Sauchiehall st. 1896

Ure, William P., Regent Mills, Sandyford. 1893

Verel, Wm. A., Fairholm, Larkhall. 1883

Walker, Adam, 26 Newton place. 1880
590*Walker, Archibald, M.A. (Oxon.), F.I.C., F.C.S., 8 Crown terrace, Dowanhill. 1885
Walker, J. W. O., 63 Montgomerie street, Kelvinside. 1896
*Wallace, Hugh, Bank of Scotland, 544 St. Vincent street. 1879
*Wallace, Wm., M.A., M.B., C.M., 25 Newton place. 1888
Wallace, William, M.A., Central Higher Grade School, Leeds. 1890
595 Warren, John A., C.E., 115 Wellington street. 1887
Watkinson, Wm. H., Whit. Sch., M.Inst.Mech.E., Professor of Steam and Steam Engines in the Glasgow and West of Scotland Technical College, The Pines, Crookston. 1893
Watson, Archibald, 5 Westbourne terrace. 1881
Watson, James, 25 Sandyford place. 1873
*Watson, John, 205 West George street. 1886
600 Watson, Joseph, 225 West George street. 1882
*Watson, J. Robertson, M.A., Professor of Chemistry, Anderson's College Medical School. 1891
*Watson, Thomas Lennox, I.A., F.R.I.B.A., 166 Bath street. 1876
*Watson, Sir William Renny, 16 Woodlands terrace. 1870
Welsh, Thomas M., 3 Prince's gardens, Dowanhill. 1883

605 Wenley, James A., Bank of Scotland, Edinburgh. 1870
Westlands, Robert, 4 Dixon street. 1869
Whyte, A. C., L.D.S., 42 Dundas street. 1892
*Whitelaw, Thomas N., 87 Sydney street. 1892
*Whitson, Jas., M.D., F.F.P.S.G., 13 Somerset place. 1882
610 Whytlaw, R. A., 1 Windsor quadrant, Kelvinside. 1885
Widmer, Justus, 21 Athole gardens. 1887
Wield, John, 9 Barns street, Ayr. 1895
Williamson, John, 65 West Regent street. 1881
Wilson, Alex., Hydepark Foundry, 54 Finnieston street. 1874
615 Wilson, David, Carbeth, by Killearn. 1850
Wilson, John, C. E., 154 West George street. 1895
Wilson, Robert, Glasgow Water Trust, City Chambers. 1893
Wilson, William, Virginia buildings. 1881
Wilson, Wm., Schoolhouse, Pavenham, Bedford. 1889
620 Wilson, W. H., 21 Hope street. 1881
Wingate, Arthur, 10 Prince's gardens, Dowanhill. 1882
*Wingate, John B., 7 Crown terrace, Dowanhill. 1881
Wingate, Walter E., 4 Bowmont ter. 1880
Wood, James, M.A., Glasgow Academy. 1885
625 Wood, Wm. Copland, Turkey-red Works, Alexandria. 1883
Wood, W. E. H., 40 Candleriggs. 1891
*Wood, Wm. Jas., 38 Cochrane street. 1893
Wright, Robert Patrick, Professor of Agriculture, Glasgow and West of Scotland Technical College. 1895

Yellowlees, D., M.D., LL.D., Physician-Superintendent, Gartnavel. 1881
630 Young, John, 2 Montague terrace, Kelvinside. 1885
Young, John, 88 Renfield street. 1881
*Young, John, jun., M.A., B.Sc., 38 Bath street. 1887
*Young, Thos. Graham, Westfield, West Calder. 1880
634 Younger, George, 166 Ingram street. 1847

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